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[Continued from SUPPLEMENT No. 172, page 2739.]

NOTES ON THE MICROSTRUCTURE OF SPIEGELEISEN.—III.

Condensed from a Report by A. MARTENS to the Society of German Engineers.

B.—POLISHED SURFACES.

SINCE the publication of the preceding articles I have somewhat improved my method of polishing, by substituting, in the two finishing operations, plates formed of hard pitch for glass plates. I made them by filling flat tin vessels of the required size with the molten resin, and smoothened the surface by means of a wet smooth plate. The surface is provided with a few cavities for taking up coarser particles of emery by scratching it slightly with a knife. In grinding and polishing I obtained the best results with jeweler's rouge.

The appearance of polished spiegeleisen under the microscope is very interesting, as might be expected from the results of previous observations.

(1/100 in)

FIG. 1.—SPIEGELEISEN FROM ROLANDSHUETTE, 100 : 1.

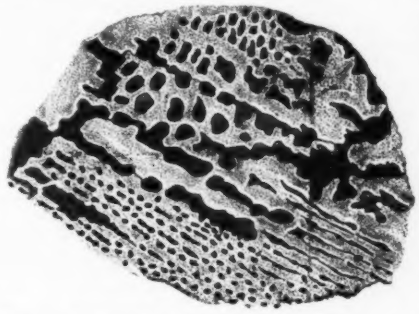


FIG. 2.—SPIEGELEISEN FROM WISSEN, 342 : 1.

FIG. 7.—SPIEGELEISEN FROM WISSEN, RICH IN MANGANESE. TRANSVERSE SECTION. 100 : 1.

TRANSVERSE SECTION OF CRYSTAL.

LONGITUDINAL SECTION OF CRYSTAL.

FIG. 3.—SPIEGELEISEN FROM WISSEN, 342 : 1.

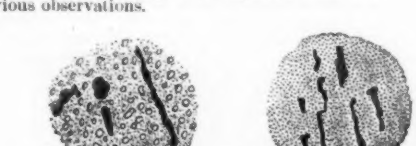


FIG. 4.—FERROMANGANESE FROM OBERHAUSEN. LONGITUDINAL SECTION. 150 : 1.

(1/200 in)

FIG. 5.—SPIEGELEISEN FROM ROLANDSHUETTE, 200 : 1. TRANS. SEC.

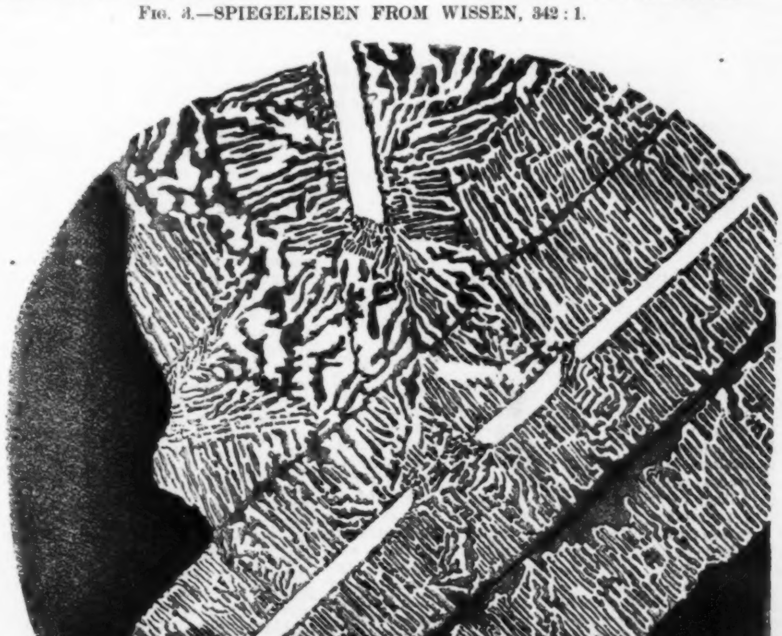


FIG. 6.—SPIEGELEISEN FROM WISSEN, 100 : 1. TRANSVERSE SECTION.

A polished surface obtained from a tabular crystal found in a cavity by cutting it longitudinally presents a various appearance, depending greatly upon the distance from the central portion of the crystal. When the latter is only superficially ground and polished, numerous spots of various size are observed, which are placed in nearly equal distances from each other and form regular figures. When the crystal is cut nearer to the center, these spots are scarcer and irregular in form and disposition. On carefully prepared surfaces these spots appear plainly already without the aid of chemicals, but they become at once very clear when the object is treated with very dilute acids. They may thus be ranged with the etched figures spoken of before.

When heated, the object begins to color first where it is covered with these figures. When a larger object is warmed gradually from end to end, these spots turn light yellow, on bluish white ground, and they gradually become darker, passing through orange, red, violet, and blue into green. At the stage when the figures are violet, the surrounding portions of the object just begin to turn yellow. They become gradually red and violet, and when we discontinue the heat at this point, we perceive an emerald green picture, drawn on dark violet ground. This is likely to mislead observers, who often take the green, light portions for elevations, while they are in reality depressions.

The transverse lines observed in the crystalline scales of spiegeleisen are also observed on the polished longitudinal surfaces of cavity crystals, or fragments of them.

In case the iron is rich in manganese, the crystallizing tendency is very strong. The whole mass seems to consist of numerous long crystals. Frequently small round elevations of a dark color are observed on newly prepared objects. These generally consist of small particles of pitch adhering to the object, and may be easily removed by a brush. Fig. 4 represents their appearance. We also observe the fern-leaf-shaped and etched coniferous figures corresponding to the crystals of similar shape. The latter, as we have seen, are formed by disintegration of the crystalline plates and scales of spiegeleisen, consisting of pure iron, with a small percentage of chemically combined carbon. Thus it is not improbable that a certain connection exists between those coniferous crystals and these depressions of corresponding form.

Figs. 1, 2, and 3 *b* show longitudinal polished surfaces from the exterior portion of the crystal. Fig. 2 especially is very expressive of the details. The figures tend to arrange in parallel groups.

Transverse surfaces are best obtained from samples in which a number of crystals are in close proximity to each other; or, a number of separate crystals may be cemented together by pitch and ground and polished together. This is necessary to preserve the edges, which would otherwise look ragged and torn.

The surfaces show plainly that the crystal consists of a central, dense portion or nucleus, surrounded by a mass of carbonaceous iron, forming etched figures of very pretty appearance, illustrated by Figs. 5 and 6. It will be noticed, that where the nucleus is most regularly developed, the disposition of these figures will also be most regular. When the nucleus is crippled this regularity ceases. This is demonstrated in Figs. 5 and 6, at the portions where two crystalline plates tend to intersect each other.

Fig. 7 illustrates the relations existing between these figures on polished surfaces to those obtained by splitting merely. It is evident that the crystals protruding from the surface in the latter instance correspond directly to the white figures formed here by iron combined chemically with a large quantity of carbon. I have, however, not succeeded so far in obtaining proofs for the direct relations existing probably between the granular masses spoken of in the first part of this article, to the darker portions, poor in chemically combined carbon. The apparently contradictory appearance of the figures at *a*, Fig. 7, may have been caused by the branches, *b b*, of the etched figures, which have broken through the mass covering them.

From the observations so far described I have drawn the following conclusions:

1. The texture of spiegeleisen, *i. e.*, the chemical combination of iron and carbon, is crystalline and fibrous, and the crystals are of the rhombic system.

2. The chemical combination of iron and manganese is brittle and crystalline.

3. Crude spiegeleisen is a mixture of iron containing carbon as a mechanical admixture, and iron containing carbon in chemical combination. The disposition of these constituents, as well as others accidently contained in the iron, is governed by certain laws, and the iron of the former character crystallizes according to the quadratic system.

THE TREATMENT OF IRON TO PREVENT CORROSION.*

By PROFESSOR BARFF, M.A.

IT is now more than two years ago since I had the honor of introducing to your notice in this room a process for the prevention of corrosion in iron; and it was through the Society of Arts that it was first made known to the public. My paper then met with a very flattering reception, both from this society and from the public press. An article appeared in the *Times*, which, written with great ability, gave to it a claim to public consideration, and with one or two trifling exceptions, it was well spoken of in all directions. The exceptions to the general desire manifested to receive well a process which, if practicable, was highly desirable, as being likely to increase largely the use of iron, and to enable it to replace, for certain uses, other metals which were injurious to health, were not founded on reasons of sufficient force to cause me to notice and answer them, and some of them, which could only result from the inner consciousness of those who made them, without an atom of proof, have been fully answered by the work which has been subsequently carried out on a larger scale at my laboratory at Kensington. I was blamed by some for bringing out my invention too soon; but I think that you will see that, by following the course I did, I was enabled to give specimens to those who have very thoroughly tested for a long time the goodness of the process; so that I, to-night, stand before you armed with a large amount of experience, and with testimony from others on whose word and judgment reliance can be placed. In answer to some remarks made by the chairman on the night when I read my first paper, Admiral Selwyn stated that the black oxide of iron had stood the action of sea water for ages, and he therefore advised us to look to nature for a proof of its enduring properties, on the shores of New Zealand, where quantities of it had existed unchanged since the creation of the world. No one who has a right knowledge of its properties could doubt its power to resist atmospheric influences, and even the action of sea water; but the doubt that did exist in the minds of many was whether it could be produced artificially on iron, so as to keep its place, and enable the iron beneath it to resist their action as well; or, rather, I should say, whether its adherence to the iron was so complete and perfect as to protect it from them. Pieces of iron will be shown you which were exhibited on that occasion, which have been exposed ever since, and you will be able to judge for yourselves whether the protection afforded by the black oxide is complete and perfect, or not. I feel that I ought, before proceeding further, to notice briefly one or two of the exceptions to which I have alluded in the reception which my first paper met with. One was that the process was not original; that I had no right to claim, as my discovery, what had been known to chemists for years. I will quote from my paper, and then you will see whether I deserve this charge or not: "In every school where chemistry is taught, in the most elementary lecture on hydrogen, the pupils are told that, if they pass steam over red-hot iron filings, contained in an iron tube, they will be able to collect and burn the hydrogen gas at the opposite end of the tube to where the steam enters. For a long time it was thought that the particles of black oxide formed by this decomposition of the steam were pulverulent, and could not be made to cohere into a solid mass." It is manifest that I could not claim as my invention what I stated was already known. Another exception was that the process might be of use for small articles—pots, pans, etc.—but that it could not be applied to large articles, and, even if it could, it would so materially weaken the iron that dependence could not be placed on its strength; in fact, if I remember rightly, a solemn warning was given to persons not to trust to it. Now, that the process is only applicable to pots and pans, etc., the articles before you will disprove. At the beginning of my experiments, I did not wish to incur a great outlay, and, therefore, the chambers or muffles used were not large. A year and a half ago I had a chamber built of fire brick, and that has been in use ever since. In it articles six feet long have been treated; and if the chamber were 12 feet long, or 20, articles of such lengths could be treated as well as those which you see before you. As to the action on the strength of the iron, bars treated have been tested for breaking and tensile strain, and the result is that the strength of the iron is not affected, and the persons who tested them assert that they would not hesitate to use the process because of any injurious effect which it has on the strength of iron. I need not do more this evening than briefly remind you that my process consists in oxidizing the surface of iron by means of superheated steam. In my former paper a description of the rusting of iron will be found; it is enough for my present purpose to state that the black oxide of iron is unaltered by any of the ordinary influences which produce red rust, and which, therefore, cause the destruction of iron.

The points which I have to bring before your notice this evening are those which two years' experience has enabled me to discover in the method of working the process; and these are very important, because formerly there was a want of certainty in performing it which gave very unequal results. During the last eighteen months I have been able to give constant attention to it, which I was not able, from my engagements, to do before, and now I can assert that it can be conducted with ease and with perfect certainty. In the specification of my patent, the method of performing the necessary operations is given, but considerable practical experience is required, which it is impossible to describe in writing. In the earlier experiments performed at my laboratory at Kilburn, it was often found that the coating of black oxide scaled off wrought-iron articles. This is never the case now. This scaling resulted from an insufficient and irregular supply of steam to the muffle during the operation, whereby air was not excluded, but was often forced in from the want of a sufficient pressure of water on the superheating pipes. Air must be completely excluded from the oxidizing chamber, because, if the oxidation of the iron depend, during any part of the process, on the oxygen in the air, such oxide formed will not adhere to the iron properly. This I have proved by submitting iron to oxidation by dry air, and in every case wrought iron has, when so treated, lost its coating, which has flaked off in scales; and in the case of cast iron, the oxide on exposure comes off in a very short time, and therefore does not provide perfect protection to the iron. If, however, the air forced into the chamber be moist, the same result occurs with wrought iron, but with cast iron the coating formed does adhere for a time, and the length of its adherence is proportionate to the quantity of moisture present in the air. If the air be forced into the ordinary chamber from a vessel in which it is in contact with water, and if the temperature of the room in which this vessel is be high, as in such a case it must be, the quantity of moisture converted into steam, when at the temperature of the iron to be oxidized, will be great, in fact enough to oxidize the iron, for very little steam is required to oxidize a great weight of iron, but then the oxygen of the air will take part in the action, and whenever the iron is oxidized by the oxygen of the air its adherence will not be complete, and though by being mingled with the other oxide it may have a certain amount of stability, yet in a short time it will come off. I exhibit two specimens in illustration of this, one of cast the other of wrought iron, both of which have been exposed in the open air for some time; the piece of cast iron did not rust for some time after it was exposed, but the wrought iron flaked and rusted at once. It appears, therefore, to be absolutely necessary to secure a good result, that air must be completely excluded from the oxidizing chamber.

For a long time I experienced considerable trouble from the appearance of small spots of rust on articles otherwise well coated, which were immersed in water. The spots of rust appeared to increase in size, but on examination it was found after washing off the rust, which could be easily removed, that it originated from small openings in the coating of black oxide. It required a magnifying glass to see these openings; the rust did not spread by more of the iron surface rusting, but because the rust formed in these minute cracks was carried out by the water in which the articles were, and it was therefore diffused about. Such rusting has no effect on the strength of the iron, and after a few cleanings it ceases altogether. However, I felt that it was very necessary to prevent it, and that led me to seek carefully for its cause. When iron is heated it expands, when cooled it contracts. If iron be heated in an oxidizing chamber it expands; its pores, so to speak, open. If a jet of superheated steam be admitted at a temperature lower than that of the iron in the chamber, the iron will contract, and then will decompose the steam: of course it must be at a sufficiently high temperature to do so. Now, the iron will gradually get hotter, and it will expand again, and the first thin coating of black oxide will be in part cracked, and as the oxide goes on forming it will in part cover and fill up these cracks, but I think—in fact I am sure—that it does not do so perfectly, and hence some of them remain, the iron at the bottom of them being coated with but a very thin film of oxide. Reasoning in this way, I came to the conclusion that no contraction must be allowed to take place in the iron after the oxidizing action had commenced, and to secure this, the ordinary chamber is always kept at a much lower temperature than the superheater; and now it is never allowed to rise above five or six hundred degrees Fahr. before the superheated steam is admitted, and the steam is never allowed to pass in at a temperature less than one thousand deg. This for a long time has been our invariable plan of work, and in no case whatever have we experienced any failure as long as the apparatus was sound. Many have tried experiments, independently of me, but in all cases I have heard complaints that they have not succeeded, and I feel sure that the want of success has been due to one of the causes I have mentioned, or to another which I described in my former paper, viz., the presence of moist steam

When asked by my lamented friend, your late able secretary, to read another paper on my iron process, I willingly consented to do so, because it would give me the best method of making public and explaining the difficulties I had met with and overcome, but which were still troubling others who take a real interest in the process. It has always been my opinion that the best way of forming the black oxide on iron is to conduct the process by means of superheated steam alone, because the steam, being the source of heat to the iron, raises its temperature to that at which it can decompose steam, so that oxidation commences immediately the iron is hot enough. When the iron is heated in the chamber, before the steam is allowed to act upon it, there is always danger of air getting into the chamber and forming a film of oxide before the steam gets to work, and this is a thing to be avoided. I have only been able to experiment with superheated steam alone on a small scale, and the large chamber has flues up its side which would conduct off the heat if it were attempted to raise its temperature by superheated steam alone. I may be here misunderstood. The flues at the sides of the chamber would cause cold air to circulate round it, and the heat from the superheated steam would thus be conveyed away. The experiment I did perform was with an iron muffle, similar to that which was used in the early experiments. This was surrounded with fireclay, to act as a non-conductor of heat. Steam, at 1,500 deg. Fahr., was injected into it for a short time, and then the articles to be treated were put inside it, and the steam was again let in. In a short time the muffle and its contents became red hot, and, after a few hours, were found to be well coated with black oxide. I could not work this process on a large scale, for I have already, through the assistance of a friend, expended a large sum of money in experiments, which have resulted in my being able to state that my process is now commercially perfect, and is waiting the enterprise of gentlemen in the iron trade to take it up and use it. When I last had the pleasure of addressing you I spoke with diffidence, and I could not give definite answers to those who questioned me; now I can speak with confidence, and though I cannot, perhaps, reply to all questions to your entire satisfaction, yet I can assert that there is no reason why this process should not be largely adopted. Adopted it will be, for it is a success, and has been proved to be so by the testimony which I have the pleasure of submitting to you. But, before submitting these testimonials, allow me to say a few words about the properties which this artificially formed black oxide possesses, as to which I could not testify in my first paper. It gives great hardness to the surface of iron, when the coating is sufficiently thick; by this I mean when it is even less than one-sixteenth of an inch. An ordinary flat rasp will not remove it without great labor; it resists emery powder, as I stated in my first paper; but now I have proved that it will for a long time resist a rasp, and will remove pieces of steel from it. This has been witnessed by many, among these by M. St. Yves, Engineer in Chief of the Ponts et Chausées, Paris, who was sent over to report on the process, and Professor Frankland. Substances which adhere to iron, zinc, and enamel, will not adhere to it. Saucepans in which arrowroot and other sticky substances are cooked can be cleaned with the greatest ease, after they have been oxidized, a simple wipe removing all dirt. I exhibit a saucepan which has been in use at my house for two years, and a wrought iron stew-pan which has done about six months' service. I have a whole set of stew-pans at home, and my cook prefers them much to any others. Dr. Mills, of Glasgow, testifies to the same property. You see before you a urinal which was in constant use at my laboratory for months, and was then sent to be used here two months ago. There are no deposits on it. I had water evaporated in an oxidized pan for six weeks—common tap water; the water never boiled, but was slowly evaporated. The deposit found was removed with a duster; it did not stick to the iron. This is a matter of great importance to boilers, and for pipes through which water is to be conveyed.

Now, articles coated can be submitted to a high temperature, even a red heat, without the coating being injured or disturbed. One of the appended testimonials speaks to this.

I have written to most of the gentlemen to whom specimens were sent two years ago, after my first paper, and most of them have kindly replied. Their letters I have published, even those which show that at present my process does not meet their requirements. Where it has not answered, I have added in a note my own remarks for what they are worth. At present I fear that iron wire cannot be treated successfully—the wire can be treated and will not rust, but it cannot be bent to a sharp curve without the coating coming off. I show a specimen to prove that the wire, when not bent, does not rust, and that articles made of wire can be made non-rustable provided they be not stretched beyond a certain point. Riveted iron plates can be most successfully treated; the process tightens the rivets and assists the calking; the plates before you show this. I have not solved the question of riveting plates after treatment, but I am sanguine that I shall be able to do so. Weights were treated for the Government, and submitted by Mr. Chaney to tests, and the process is now recommended by that department for the standard weights throughout the country. I also exhibit two specimens, one of oxidized, the other of common iron, on which gold leaf has been put in the ordinary way, with oil gold size, and I think they illustrate well that even where it is desired to paint or gild iron to be placed in exposed situations, it is very desirable to have it first treated by my process; both the specimens have been out of doors for two months, exposed to rain and snow; for some days they were completely buried in snow.

I regret to say, gentlemen, that I cannot speak very definitely as to the cost of the process. I do not wish to delude any one by a statement that it can be done for so much per ton. It is simply impossible to do this, as you will see. Hollow goods—such as saucepans, etc.—will take up a much

* A recent lecture before the Society of Arts, London.

larger space per ton than a ton of 56 lb. weights, and this shows how fallacious any general statement on this head must be. My experiments have not been conducted with special regard to economy, but to efficiency, and, having settled this point, economy must now be inquired into. This is rather the work of the manufacturer than mine; but this much I can say for your guidance, that, even with my means, the cost for light articles does not exceed that of galvanizing. But I do think that, if the treatment gives a permanent protection to the iron, articles treated by it should command a higher price than those which have been treated by a less enduring process. My experience tells me that different kinds of cast iron behave differently under treatment. Some kinds require longer exposure to the action of the superheated steam than others. Why this is I cannot as yet find out. Of this class is the iron in which the carbon is in more perfect chemical combination as a carbide. This iron is whiter than the other kinds. There are before you specimens which have resisted the rusting action of air in the presence of water. The two statues exhibited and other articles are of a different kind of iron; they required a shorter exposure, and have stood equally well. I have not yet met with any sample of cast iron which could not be properly treated. Wrought iron requires a somewhat different treatment; a lower temperature, about 900 deg. Fahr., suits it best, and steel also. It is not well to expose articles very different in bulk at the same time; all that are put into the muffle should be pretty nearly equal in bulk. I mean that very heavy articles, such as a 56 lb. weight, should not be treated with these gutter spouts. Cast and wrought iron should not be treated together; but all these are matters which a little experience will regulate perfectly. Sometimes the sand from the mould adheres to cast iron; this is often the case inside pipes; it is of no moment, for the sand itself gets so firmly fixed on the coating of black oxide that it assists in protecting the iron. I have proved this by severe experiments. In clearing off the rust from iron before it is submitted to the action of superheated steam, the usual method is employed; it is immersed in dilute oil of vitriol, and after washing is put into some bran water; this last operation is to remove any basic sulphate of iron from the surface. If this basic sulphate is not completely taken away when the iron is heated, it is reduced, and red oxide of iron is left on the surface, which has the color of the red oxide used for paints, and you will see some articles so colored before you; this red oxide does not prevent the formation of the black oxide beneath it, and does not interfere with its stability; it is therefore of no importance, except to the appearance of the articles.

Having now trespassed so long on your patience and time, I have only to say that I hope you will ask me any question you please, in order that I may, if I can, resolve any doubt which you may feel as to my process. I have also the pleasure of stating, that Mr. John Spencer, of West Bromwich, will shortly be prepared to treat articles which may be intrusted to him.

The author then read a large number of certificates from persons who had used the process or prepared articles with success. Among the articles were closet pans, lamp posts, keys, bolts, pins, corrugated sheet iron, boiler plates, pots and kettles, wrought iron bars, iron pipes, steel springs, etc.

(To be continued.)

CHEMICAL NEWS NOTICES.

RESEARCHES ON ELECTRIC FISHES.—E. J. MAREY.—Physiologists have been struck with the analogies presented by a muscle and the apparatus of electric fishes. These two kinds of organs, both subject to the will, and provided with nerves for centrifugal action, have, further, a very analogous chemical composition, and even some points of structural resemblance. These views, put forward before physicists had developed the theory of the correlation of forces, were necessarily very vague. It might even be conceived that in the living organism, as well as in our physical instruments, analogous conditions might produce either mechanical work or electricity. Having found that muscular acts are complex, *i.e.*, that a muscle in tetanus or in contraction executes a series of minute successive movements, which the author calls shocks, which accumulate to produce muscular contraction, he has examined the discharge of the torpedo, and found there a similar complexity. Having passed this discharge through an electro-magnetic tracing apparatus he found that it was made up of minute shocks, which recur at the rate of 150 in a second. Cold reduces the rate alike of the muscular and electric shocks, while heat acts inversely. Hence the author concludes that these two functions are really homologues. The gymnotus gave similar results to those of the torpedo. The latter fish, when connected with a telephone and slightly excited, produced a very short croaking. If a prolonged discharge is occasioned by pricking the electric lobe of the brain the sound produced lasts three or four seconds, and in tonality borders upon *mi* (165 vibrations).

NEW SPECTRAL RAYS IN SUBSTANCES EXTRACTED FROM SAMARSKITE.—LECOQ DE BOISBAUDRAN.—On examining with the spectroscope, both by absorption and by means of the electric spark, the products of his operations on the mixture of earths from samarskite, the author has observed rays or bands not to be referred to any element formerly known, and not corresponding to the descriptions of the spectra of the earths recently announced by MM. Delafontaine, L. Smith, Soret, and De Marignac. These new rays of absorption and emission seem to belong to one and the same body. The emission spectrum is composed of four bands shaded toward the left and formed of narrow rays, the strongest of which is the most refrangible and forms the right margin of the band. The absorption spectrum comprises two strong bands in the blue, and several rays of less importance in the green. The metal which yields these new spectra is precipitated as a double potassic sulphate along with didymium; its simple sulphate is rather less soluble than that of didymium; its oxalate is precipitated along with didymium, but ammonia separates the oxide of the new metal before that of didymium.

THE GELATINE PROCESS.*

THE process of gelatino-bromide realizes an immense advance upon the old dry methods employed in photography, by reason of the facility of its preparation, its economy, its great sensitiveness, the absence of all danger in the substances required in its formation, and the banishment from the laboratory of three dangerous products—fulmi-cotton, alcohol, and ether. My son and I have succeeded in working out a method for its preparation which will enable all persons who practice photography to work it with success and certainty. Here are the details of this process in all their naked simplicity: Place in a bottle 200 c.c. of ordinary water; add ten grammes of white gelatine of the first quality of the "comet" brand, which may be obtained of the drug merchants of the Rue des Lombards, Paris. The gelatine is then dissolved in the hot-water bath with four grammes of bromide of ammonium, and seven grammes of crystallized nitrate of silver are dissolved apart in the necessary quantity of distilled water. This solution is poured into the bromized gelatine, well shaking the bottle, and it is left about an hour in the hot-water bath to facilitate the combination of the bromide and nitrate of silver. The emulsion is then poured into a tray or porcelain dish, and it is left to get cold, when it is scraped up in small portions with a silver spoon and placed in a large jar full of ordinary water, which is agitated from time to time and renewed five or six times in twenty-four hours.

After this space of time the jelly is withdrawn from the water, drained on muslin, and then introduced into a yellow glass bottle and redissolved in the water bath when it is desired to coat plates, which is done in the following manner: Commence by warming the plates; afterwards pour upon the middle of the glass sufficient to cover the whole, and with a glass rod or brush spread it all over the surface; then place the plate on a cold marble or plate-glass slab perfectly leveled. When the gelatine is set, the plates can be placed upon a support and kept in a position where the temperature is slightly raised, taking care the obscurity is complete, because the least light will impress them infallibly. The drying occupies twelve hours, or less may suffice, as it depends on the quantity of heat and the circulation of air in the room. When perfectly dry, they ought to keep a very long time; but this trial not having been rigorously made, it is not yet possible to state precisely the duration of their keeping qualities.

This is how the image is developed:—Two solutions are made.

No. 1.

Distilled water	100 c.c.
Pyrogallic acid	1 gramme.

No. 2.

Water	1,000 c.c.
Liquid ammonia	15 "
Bromide of potassium	5 grammes.

The film is soaked in ordinary water, then covered with solution No. 1 for one minute; now add an equal quantity of No. 2; and this mixed solution completes the development. If it become strongly colored before the image is completed the plate must be well washed, and the development continued with a new mixture of the two solutions. It is washed when finished and fixed with hypo. It sometimes happens that the film of gelatine lifts during development, which is a serious inconvenience, because the negative is irremediably lost; to obviate this fault, we add to the emulsion we are going to use two or three drops of a five-per-cent solution of chrome alum. E. FERRIER.

PRESERVATION OF THE EGGS OF THE SILKWORM IN DIFFERENT GASEOUS MEDIA.—G. LUVINI.—The author has preserved the eggs of the silkworm in hydrogen, carbonic acid, oxygen, and nitrogen for about three months. Those which had been kept in carbonic acid and in nitrogen after removal hatched well and gave an almost complete yield.

NOTES ON GELATINO-BROMIDE.*

IN continuance of the experiments I have made with gelatino-bromide of silver, I send you the results I have obtained by development with the sesqui-carbonate of ammonium and carbonate of soda (sal soda, soda crystals), and which have quite satisfied me.

The liquid ammonia retailed by the dealers is so variable that there is a real advantage in employing as alkali a salt easy to weigh; and from this point of view the neutral carbonate of soda, being permanent and readily found in commerce, would be preferable to carbonate of ammonium.

I have found it useful to employ concentrated solutions of these two salts:

A.

Water	100 c.c.
Carbonate of ammonium	25 grammes.
Bromide of potassium	1 g., 20 c.g.

A¹.

Water	100 c.c.
Carbonate of ammonium	25 grammes.

or—

S.

Water	100 c.c.
Carbonate of soda	25 grammes.
Bromide of ammonium	1 gramme.

S¹.

Water	100 c.c.
Carbonate of soda	25 grammes.

I have had recourse to warm water to make the above solutions at this period of the year. A and A¹ and S and S¹ differ only by the alkaline bromide contained. The glass plate having been soaked for five or six minutes in a dish of ordinary water, I immerse it in a tray containing (for a plate 7x9½) 125 c.c. of a one-per-cent. solution of pyrogallic acid in distilled water, and I rock it about for forty-five seconds or one minute. It is nearly indispensable, I believe, to add to the pyrogallic acid in the tray twelve to fifteen c. c. of good beer, mixing them well together. I withdraw the plate and add four to five c.c. of solution A, or of the solution S, mixing well, and I re-immerse the plate for thirty to thirty-five seconds. The image has not yet appeared. I then add three c.c. of A and two c.c. of A¹ (or S and S¹ if the carbonate of soda be preferred). The plate is again immersed in the bath, and the image appears at the end of about thirty seconds, and, judging from the appearance of the negative, the development is continued by adding more or less of A or A¹ (or more or less of S or S¹).

With gelatino-bromide, which gives negatives of an extremely non-actinic color, you obtain with the carbonate of soda a vigor more than sufficient; it is, therefore, to be recommended, and it seems to me to require a shorter exposure, though my experiments have not been sufficiently numerous to enable me to affirm this statement.

The alkaline development is capable of giving any desired intensity; but, if after fixing the density prove insufficient, the image may be intensified with pyro and silver, only in this case ten per cent. of beer must be mixed with the pyro and acetic acid at the moment of using.

I have had too little experience with the bichloride of mercury as an intensifier for gelatine negatives to pronounce upon its value, so precious in the collodion processes when negatives are required for photolithography.

I beg also to call attention to an experiment which, in my opinion, tends to show that nitrate of silver reacts on gelatine to form an argento-compound. One can, perhaps, explain the rapidity of the process by the presence in the film of this combination, which plays the part of free nitrate in the wet process.

To make the emulsion I bring together the two following solutions:

Water	50 c.c.
Bromide of ammonium	2 g., 70 c.g.
Gelatine	5 grammes.
Distilled water	50 c.c.
Nitrate of silver	5 grammes.

I have thus an excess of silver about 0 g. 30 centigrammes, and this excess ought to be re-found in the water used to wash the emulsion, when, after having left it to ripen during two hours on the water bath, I pour it into a tray to set. I have used distilled water for the first washing-water, after the lapse of a certain time; and after having cut the gelatine into small squares I have kept and filtered this water. I have not found any trace of silver.*

E. LAIR DE LA MOTTE.

GELATINE PROCESS.

By H. HOULGRAVE.†

THE following will be found a good formula to begin with:

Gelatine	26 grains.
Bromide of ammonium	26 "
Nitrate of silver	46 "
Water	2 ounces.

This makes an emulsion which will be found to run through the filter and flow over the glass with unusual facility. Plates prepared with it give little trouble in development, and dry in about half the usual time. So far as I am able to test the matter at this present season of the year, these plates do not show the slightest tendency to blister or frill. How they will behave in this respect when warmer weather returns I fear is doubtful, as I think it may be taken as a general rule that the less gelatine an emulsion has in its composition the more easily will it be injuriously affected by water at a high temperature. Should, however, frilling occur—and this is the only difficulty to be dreaded—I entertain strong hopes that it may be entirely overcome by a judicious use of chrome alum.

The action of chrome alum on the gelatine film is very remarkable. If five drops only of a twenty-grain solution be added to two ounces of emulsion just before coating the plates, these when dry may be treated with impunity with water at 100° Fahr. Unfortunately chrome alum cannot be used in this way without some serious drawback, as it renders the film so hard and repellent that development becomes tedious and difficult, and the plates are particularly liable to a peculiar kind of stain. The sensitiveness is also materially reduced, and should the glasses be required for use again they cannot be cleaned in the usual way—that is to say, by merely washing with hot water.

All these difficulties, however, may be almost entirely avoided by combining a portion of glycerine with the chrome alum, and the following will be found a good method of doing so: Dissolve twenty grains of chrome alum in one ounce of water, and then add half an ounce of glycerine. Now, having prepared an emulsion ready for immediate use, to each ounce drop in five drops of the above mixture, stirring at the same time with a glass rod, thoroughly but carefully, so as to avoid the formation of air-bubbles, and proceed immediately to coat the plates. Plates prepared in this manner will not stand water at the same high temperature as when the glycerine has been omitted; but they are quite safe at 80° Fahr., and that is probably quite sufficient for all practical purposes.

ESTIMATION OF NICOTINE IN TOBACCO.‡

THE relative amount of nicotine contained in different kinds of tobacco furnishes one of the means to determine the special processes required to properly cure it, as well as the particular uses to which it is to be put. Liecke determined the amount of nicotine in the following manner: A weighed quantity of tobacco is treated three times in succession with water acidulated with sulphuric acid, the watery solutions are evaporated to the consistence of sirup,

the liquid extract mixed, under stirring, with an equal volume of alcohol, and the mixture afterwards filtered. The filtrate now contains all the nicotine in the state of sulphate, which is left behind on evaporating the alcohol. The residuary salt is transferred to a flask or retort, potassa is added, and the nicotine is distilled over, by gradually heating the flask or retort in an oil-bath to up to 250° C. (—482°

* A communication to the Photographic Society of France.

* A communication to the Photographic Society of France.

* Combinations are, in fact, produced between the salts of silver and organic matter, such as gelatine, albumen, etc. These combinations are sensitive to light, and have been already mentioned by MM. Davanne and Girard in their study upon positive proofs.—*Ed. Bulletin.*

† Read before the Liverpool Amateur Photographic Association.

‡ After *Klencke, Lexicon der Verfaelschungen*, etc., p. 689.

F.). In the distillate the nicotine is determined by titration with standard sulphuric acid.

The French Government has a monopoly of the tobacco trade and manufacture in France, and a special process is used in the Government factories at Paris for determining the alkaloid. The apparatus employed (see Fig.) acts continuously and has the advantage of effecting a complete condensation. It consists of a flask, A, embedded in a sand-bath, E, supported and partly surrounded by a sheet-iron cylinder, F, the heat being supplied by gas or alcohol flame. The flask is closed with a doubly-perforated cork; through one of the perforations is passed the tube, B, through the other the curved tube, D, the ascending portion of which is dilated, C. On the wall over the apparatus, a trough, R, is fixed, through which a continual supply of cold water passes, for the purpose of keeping the tube, B, constantly cold. The sample of tobacco to be examined is cut very fine and introduced into the oblong bulb, C, a tampon of cotton, G, having previously been inserted to prevent fragments of the tobacco from falling into the flask. The latter is charged with 100 cubic centimeters of ammoniacal ether, which is kept boiling until all the alkaloid is extracted from the tobacco. The vapors of the ether ascend through B, become condensed in that portion of the tube lying in the trough, and the condensed ether is by the pressure of the vapor forced into bulb, c, where it passes through the tobacco, and finally is driven more or less saturated back into the flask. The bend at D is, of course, necessary to produce a liquid joint, for preventing the ether from passing through the tobacco as vapor. The residuary liquid is allowed to stand in the cold until the ammonia and ether have evaporated. Finally the nicotine, which is left behind tolerably pure is determined by means of standard acid.

CLINICAL LECTURE,

Delivered at the Medical Department of the University of the City of New York. By ALFRED L. LOOMIS, M.D., Professor of Pathology and Practice of Medicine.—*New York Medical Journal.*

HEART-CLOT IN PNEUMONIA.

GENTLEMEN: The lungs which I presented to you this morning were taken from the body of a man who died recently at Charity Hospital, on the third day after his admission there. When he entered the hospital the diagnosis of pneumonia, situated in the upper part of the left lung, was made. He was so feeble that the necessary physical examination could be made with difficulty; but still he appeared to be doing pretty well until the third day, when the orderly permitted him to get up out of bed and go to the water-closet, where he died very suddenly. At the time of his death the physical signs were those of the second stage of pneumonia, with those of commencing third stage in some parts; and when the autopsy was made, it was found that a considerable portion of the lung was solid, so that it no longer crepitated when pressed between the fingers, as is the case with normal pulmonary tissue. The lower portion of the upper lobe was already in the third stage, as you will see when I pass the specimen round; while nearer the apex the disease was yet in the second stage, or just passing into the third. The extreme apex, on the other hand, was still in the first stage of the disease; so that there could be no doubt that the pneumonia had commenced at the base of the upper lobe, and thence extended upward throughout the lobe. This is a very interesting specimen, for it exhibits within a limited compass the gross appearances of the three stages of pneumonia.

The other lung was found to be everywhere covered with very thick pleuritic exudation, and, being bound to the chest-walls by numerous and extremely firm adhesions of long standing, was to all intents and purposes completely carnified. About the left lung also, I should not neglect to remark, there were well-marked evidences of acute pleurisy. The inflammatory process extended to the base of the lung, and not only involved the diaphragmatic pleura, but the inflammation had extended through the diaphragm, and involved the capsule of the spleen as well.

The autopsy also revealed still further disease, viz., well-marked evidences of acute pericarditis; there being a considerable effusion into the pericardium, with numerous flakes of organized lymph floating in it. In addition, there was found in the right ventricle an exsanguinated coagulum, and in the right auricle a dark clot of large size. As you have been informed, the man died suddenly; and from the above *post mortem* appearances, I think you will agree with me that there was quite enough the matter with him to destroy life. The right lung must have been altogether useless; and as the whole upper lobe of the left was consolidated, all his respiration must have been performed with the lower portion of that lung. Both the heart and the lungs being thus crippled, it was as much as they could do to perform their functions while the patient was in a state of rest; so that it was his getting up and walking to the water-closet which was unquestionably the immediate cause of his death.

The question now arises, Was the heart-clot responsible for this? For my own part, I do not hesitate to say that I am one of those who do not believe very much in that sort of thing. I do not deny that in one out of a vast number of instances a clot may plug up the pulmonary artery and cause death; but such an occurrence I believe to be exceedingly rare. But you must remember that you cannot have heart-clot without heart-failure: it is not till the heart itself fails that these clots are formed. There are certain exceptions to this, as in puerperal peritonitis and in pyæmia, for instance, where there is a profound alteration in the blood; but it is not of this class of cases that I am now speaking. In ordinary pneumonia I hold that the heart-clots are always of the character seen in this case; that they owe their existence simply to heart-failure, and that they have nothing whatever to do with the causation of the patient's death. I know that many are of the opinion that this mode of death is attributable to heart-clot; but at the same time I must confess that I believe those expressing such views cannot sustain them by *post mortem*.

Others get around the matter by claiming that the heart is "paralyzed" in such cases. The heart, however, is no more paralyzed than is the whole system when death overtakes the patient. This is the only sense in which it is paralyzed; and I do not wish you to be led into any such mistakes as these. The truth of the matter is, that the heart carries on its work with an enfeebled circulation just as long as it can; and when it is no longer able to do this, it stops work.

You hear from practitioners of medicine, and read in the books and journals, very much about giving carbonate of ammonia (and often in large doses) in pneumonia, with a view of preventing heart-clot. From what I have just said, however, you will readily see that this is all theory. You might as well (and better, I think) give carbonate of ammonia for the purpose of preventing the pneumonia itself as for the prevention of heart-clot. If it does any good at all in pneumonia, it is because it acts as a stimulant, and in this way helps the heart perform its work. But as to its preventing heart-clot, I am certainly unwilling to subscribe to any such fanciful opinion. In the history of pneumonia there generally comes a time when we need a diffusible stimulant, and the only question in regard to the carbonate of ammonia is this, Is it the best stimulant at our command? For my own part, I do not believe that it is, and personally I very much prefer to rely upon champagne. When the time comes to give carbonate of ammonia, it is time to give champagne: and the latter, as I have just said, I believe to be much the better stimulant of the two.

I trust, however, that no one will misunderstand these remarks in reference to heart-clot. I do not deny that clots do form in the heart in pneumonia, but I believe that this is only the case immediately before death, and that it is not due to any change in the blood itself. I hold, therefore, that it is useless to try to prevent such a thing by the administration of drugs, with the exception of such as act merely as stimulants, and thus increase the power of the heart.

HYPOCHONDRIASIS.

Here is a man in middle life, and apparently of not a very high order of intelligence, who says that he has been sick for a long time, "on and off." He complains principally of pain seated at the pit of the stomach, and of "weakness about the stomach and chest." He also feels a sinking sensation referred to the stomach, but does not vomit unless he has headache, which occurs about once a month or so. This vomiting is not very severe, and is probably due to an ordinary bilious attack recurring from time to time. When I ask him what else he complains of, he replies: "Weakness in the feet and pains in the knees, shoulders, jaws, and sometimes all over the body." He has never had any swelling of the feet, nor of the joints, although he sometimes suffers from pain in the latter. Occasionally he has some dizziness and vertigo, he says. When questioned in regard to loss of flesh, he states that he has lost "all his flesh." He first consulted medical advice about five years ago, but says he began to feel badly a long time before that. During the last two years there have been but few days in which he has not taken medicines, and these, he says, have been principally of a strengthening kind.

He has never had chills and fever, as far as he knows. Since he has been complaining he has resided part of the time in this city, and part of the time in Westchester County, New York; but he says there was no malaria in the locality where he lived. While in the country, however, he used to suffer from headaches so severe that they laid him up for some time; and the pain was worse in the daytime than at night. He does not remember ever being out of his mind at these times. He has not done any work for three months, and states that during the last two years he has not been able to work more than half the time. When asked if he ever had any serious illness besides that which he had mentioned, he says that he had two attacks of pneumonia, two and four years ago respectively. He was sick five weeks the first time and two weeks the second time; and the first pneumonia was on the left side, while the last was on the right. He has three children, who are all healthy, and his family history is also good. He states that he does not drink, and that he does not suffer from involuntary seminal emissions; nor has he indulged in venereal excess.

Well, it would be pretty difficult to make out a diagnosis from the history which you have just heard; and so we will now institute a physical examination, and see if that will throw any light on the case. In the first place, we ascertain that there is nothing abnormal about the pulse, and that the tongue is in very fair condition, while the countenance of the man is not particularly indicative of disease. On looking at the gums, we do not find any evidences of the action of either mercury or lead upon the system.

Before going on any further with the case, I should like to remark that this patient belongs to a class which will come under your observation very frequently in the future, and which it is of great importance that you should thoroughly understand. I presume that about one fourth of the physician's ordinary practice is concerned with just such cases as that now before you, and they generally cause more trouble than any others. You may be very much interested in remarkable cases of aneurism and other unusual disorders; but you will meet with a hundred such cases as this where you will see one of aneurism. It is therefore a matter of some consequence that you should be able to recognize them when they come in your way, and that you should know how to deal with them properly.

The man now being stripped, we make an inspection of his chest, and find that it seems to be quite well developed. The left shoulder is seen to be a little higher than the right, and there is a slight lateral curvature of the spine. In fact, there is a double curvature in opposite directions; but these compensating one for the other, the trunk remains pretty nearly straight. The apex-beat of the heart is in its normal position, and I cannot see that there is any unnatural pulsation anywhere about the thorax or abdomen. When the patient takes a deep breath, we find that abdominal respiration is good, and that there is even more than the ordinary expansion of the chest. When percussion is practiced, we find that there is a little dullness over the upper part of the right lung in front, as compared with the left; but this may be nothing more than the natural condition, for you must remember that normally the right apex is slightly duller on percussion than the left. Still, the patient has had pneumonia; and as with this there is very apt to be more or less pleurisy, it is quite possible that a little permanent thickening of the pleura in this portion may have resulted in consequence. Nothing out of the way is perceived when auscultation of the chest is made, and we may therefore exclude any present diseases of either the lungs or heart.

The dullness on percussion is normal in extent both in the hepatic and splenic regions, and on making a careful examination of the stomach, as well as the whole abdomen, I am not able to detect any tumor, or anything else abnormal. In addition we find, so far from there being much emaciation present, that all the thoracic and abdominal muscles are very well developed.

The physical examination being, then, a negative one, and all the symptoms complained of being of a very vague and uncertain character, we can arrive at but one conclusion, and that is, that the man is in reality suffering only from hypochondriasis. This is the only diagnosis at which we can arrive after a thorough investigation of the case. The only thing needed to make it complete is an examination of the urine; but as we have not discovered anything whatever to point toward disease of the kidneys, I think it can be safely dispensed with here.

Now you see, I trust, why this is such an important case for you to understand. I do not doubt that the man suffers from pains in various parts of the body at times; but what man or what woman is free from them? Patients of this kind go around from one physician to another, vainly seeking relief from what they imagine the most serious diseases, and often injuring their health to no small extent by the vast quantity of medicine which they take. It is your duty to come out perfectly frankly and tell them that they have no organic trouble whatever, and that the less medicine they take the better. As to our friend here, we will endeavor to impress upon him the fact that, notwithstanding the ills that are so tremendous to his imagination, he is a perfectly healthy man. We will tell him that he must stop thinking about himself and must stop dosing himself; that he must keep away from the doctors; that he must go on with his work; and that when he feels his pains coming on, he must work all the harder until they go away again.

TRAUMATIC INSANITY.

AT a recent meeting of the West Chicago Medical Society Dr. D. R. Brower read a paper on this subject and reported three cases. The first case was that of an army officer, who, before injury, was noted for his kindliness of disposition, temperance, and affection for his friends and family. He received an injury of the head, a scalp wound, with possibly a slight injury to the skull, from which he apparently recovered. Afterward, his emotional disposition began to change; he would have cephalalgia, at times very severely, and soon got to taking liquor to intoxication at these times. At such times he was suspicious, vindictive, and brutal, and would beat his wife and children. These attacks were fits of mania. They continued at intervals as long as the case was kept track of. The second case was that of J. K., lately tried in a local court for murder. He was an Irishman of middle age. Had been educated by a brother who was a priest of the Catholic Church, to which the patient was devotedly attached. He was naturally kind and peaceable. He received, while in the army, a head wound, involving the skull in a depression. Some months afterward he began to be suspicious of those about him at times; to have severe attacks of cephalalgia. Finally he would have attacks of *petit mal*, and the reporter thought there was, from the evidence, no doubt he had had two fits of *grand mal*. He had become estranged from most of his old friends; repeatedly left situations for the sole reason that he thought his employers and comrades were "down on him;" had acquired a mortal enmity toward the Catholic Church and the members of its orders. In his attacks of cephalalgia he was often thought dangerous by those about him, who kept out of his way. He had camphor about him constantly to keep evil spirits away. He woke out of a sleep one night and shot his wife who was beside him, and then shot himself. The wife died. He, recovering, was tried for murder. The verdict was that the prisoner was guilty of murder, but that at the time of the trial he was insane. Shortly afterward he cut his throat in his cell and died.

The third case was of a man also tried in the local courts for the murder of his wife, but who, at the time, and at the time of the murder, was so unmistakably insane that nobody doubted it, and he was sent to the asylum. In this case the insanity was clearly traceable to an injury of the head, received years before, and which was followed slowly by, first, headache, then inattention to business, then by other more positive symptoms of insanity.

Dr. Brower thought these cases illustrated the chronicity and slow development of insanity from traumatic injuries to the head; the comparatively slight injury required often to cause insanity; the fact that cephalalgia is the first symptom, which is followed by emotional disturbance, which latter always precedes intellectual aberration, and finally, the general absence of anything like acute meningitis. He believed that in many such cases there was chronic meningitis. The teaching of cases like those described was, that no injury to the head was so slight as not to be important. At the same time it was true, hardly any injury to the head was so severe as to be despaired of.

Dr. E. L. Holmes related the history of a case of a naval officer who had received a wound of the head from a shell. Recovering from the injury, as was supposed, he not long afterward began to be emotionally changed; was unreliable, soon became dissolute in his habits—a thing unknown before his injury—and was quarrelsome. He was finally dismissed the service for drunkenness. On returning home, he was found to have symptoms of intoxication when he had not partaken of liquor, and was secretive as to his history while in the service. On his death, an autopsy revealed an abscess of the brain, just beneath the seat of injury in the skull.

Dr. H. M. Lyman related the history of several cases very similar to those reported by Dr. Brower. In one case there was a scalp wound over the left eye, made by a blow from a tin dipper. This healed. In three months convulsions occurred, and the wound re-opened; hemiplegia took place. A post-mortem examination discovered an abscess of the left frontal lobe. In another case—that of a man in jail for some crime—there was found a considerable depression of the left parietal bone beneath a cicatrix. The man was dumb, he thought from aphasia, as he was able to make with a pencil, when asked the cause of his injury, a hieroglyphic, evidently meant to represent the word glass, which Dr. L. took to mean that the injury had been inflicted by a blow with a beer-mug. The man was moody, and fancied he was followed by some one. He was clearly insane.

Dr. A. B. Strong described the case of a lad who had received a kick from a horse upon the left side of the head, just above and a little in front of the ear. The scalp was cut, but he thought the bone was not fractured. Insensibility was at first produced, which disappeared rapidly. In four days there appeared suddenly paralysis of the left side of the face and the right arm, and aphasia. No other paralysis was present.

A slow recovery from the paralysis followed. The aphasia improved so far that, in a few weeks, the boy could talk well when free from excitement, but, on any perturbation of spirit, or an attempt to talk rapidly, he was dumb.

ELASTIC ADHESIVE PLASTER.

W. P. MORGAN, M.D., writes to the Boston *Med. and Surg. Jour.*: I have been trying to find an elastic covering that, being attached to the skin, would yield to the movements of that membrane and the parts beneath it without causing an unbearable sensation of stiffness or an uncomfortable wrinkling.

As there was nothing in our market to suit me, I procured some India-rubber, and giving it a coat of plaster, such as is recommended in Griffiths' Formulary under the name of Boynton's adhesive plaster (lead plaster one

pound, rosin six drachms), I found the material I wished. After using it as a simple covering for cases of psoriasis, intertrigo, etc., I extended its use to incised wounds, abscesses, etc., and found it invaluable.

Placing one end of a strip of the plaster upon one lip of the wound, and then stretching the rubber, and fastening the other end to the opposite lip of the wound, I had perfect apposition of the severed parts, the elastic rubber acting continually to draw and keep the parts together. When I have been unable to get the sheets of rubber, I have used the broad letter bands (sold by all stationers) by giving them a coat of the plaster.

TREATMENT OF CEREBRAL APOPLEXY BY INJECTIONS OF ERGOTINE.

MR. FOSTER reports two cases of pronounced apoplectic coma, which were treated by the injection of twelve drops of a solution of ergotine, containing seven and a half grains to the drachm of vehicle. In both cases the coma disappeared soon, and recovery took place. The essential condition for the success of the treatment is, that the injection be administered at the beginning of the attack, before there has been time for an extensive extravasation of blood. Mr. Foster recommends injecting the fluid between the muscles of the forearm, and not merely under the skin, where it is liable to excite suppuration.—*The Lancet.*

TREATMENT OF DISTEMPER.

IT will be interesting to lovers of the canine species to hear of a simple remedy for distemper. At the quarterly meeting of the Scottish Metropolitan Veterinary Medical Society Mr. Baird mentioned the case of a colly dog in the last stage of the disease, and which its owner had determined to destroy. Shortly after being treated with doses of strong coffee and a little sweet milk, the animal, however, so far recovered as to be able to stand and walk. The chairman of the meeting said the case seemed almost unique.—*London Lancet.*

A NEW, CHEAP, AND SELF-GENERATING DISINFECTANT.

UNDER this title, Dr. John Day, of Geelong, Australia, recommends for use in civil and military hospitals, and also for the purpose of destroying the poison-germs of smallpox, scarlet fever, and other infectious diseases, a disinfectant ingeniously composed of one part of rectified oil of turpentine and seven parts of benzine, with the addition of five drops of oil of verbena to each ounce. Its purifying and disinfecting properties are due to the power which is possessed by each of its ingredients of absorbing atmospheric oxygen and converting it into peroxide of hydrogen—a highly active oxidizing agent, and very similar in its nature to ozone.

PROBABLE CAUSES OF ARCTIC HEAT IN FORMER TIMES.

By Ex.

A THEORY to account for the former high temperatures that existed in the Northern Temperate and Arctic regions. On the necessarily different conditions that existed in the diurnal phenomena; the relation between latitude and temperature, etc., etc.

Prop. 1. The development of vast coal formations after the silurian period was undoubtedly caused by the deposit in place of an enormous aggregate of vegetable growth, fostered by circumstances and by conditions not now existing, and a development of terrestrial temperature now unknown in high latitudes.

2. That we may have good reason to believe that at the period when the coal fields of the devonian and carboniferous periods, and down to the tertiary age even, were formed, abnormal causes contributed to produce a peculiar rapidity and profusion of growth now unknown; that this was mainly due to excessive conditions of heat and moisture, aided, perhaps, by an excess of carbon, also seems generally reasonable and satisfactory, but yet does not account for the higher temperature that existed from 37° north latitude to well into the Arctic regions, for a period, we may say, to the end of the miocene period.

3. That all that is claimed for, or in explanation of, the vast accumulation of coal formed in the carbonaceous age can as justly be claimed for the coal formations of the cretaceous and tertiary periods in the New World, which, in area, even exceed all the so-called "true coal measures" of Europe, Asia, and America combined.

4. That, to account to-day for the high temperature that once prevailed even as far north as the Melville Islands in the Arctic regions, we believe the following hypothesis might explain what has hitherto been an unexplained problem, which hypothesis we propose to develop and consider. And we will here say that we firmly believe that the anomalies of latitude, temperature, and the seasons, now prevalent from the equator to the pole, did not then exist in the devonian, the carboniferous, and to the end of the cretacious and tertiary ages; and, using De Candolle's terms, the growth of "megathermous" and "mesothermous" vegetation in those geological periods was caused by a totally different condition of temperature and the seasons.

5. That at a period of time (we might say the devonian age) we may suppose that the motion of the earth in space was the same as now, with the sun as the central point of the solar system, but that a source of attraction then existed, situated in the vast stellar space outside of the earth's orbit around the sun, and at an immense distance from the earth, this attraction being powerful enough to arrest or modify the motion of the earth on its axis.

6. That in the earth's yearly revolution around the sun this source of attraction kept the earth's longest axis (that of the equatorial ellipse) constantly parallel to this line of attraction in stellar space.

7. That as a consequence of this modified or destroyed axial motion of the earth, the alternations of day and night, and of the seasons, and consequently the diurnal temperatures of the long days and long nights, were totally different from present conditions.

8. That, as a consequence of the lengthened period of time that the heat and light of the sun were continued in high latitudes at either pole, the long twilight, the prodigiously longer days at either pole, the long periods of moonlight, joined to excessive evaporation of water from the large areas of seas and lakes that then exceeded our present water surfaces, must have been singularly favorable for tree and plant growth, and made the flora of high latitudes profuse and almost unlimited in their season. We would thus easily conceive that the Arctic Continent could readily support a growth of trees of magnificent foliage and size. We even think, with the present knowledge we have, that in the carboniferous age the anomalies of temperature and the different seasons, the whole "*tout ensemble*" of diurnal phenomena, were then at their maximum; that in the cretaceous age they were also much modified, for between these two radical periods of geological successions we find very conclusive and precise indications of a successive adaptation of the organic world to strongly modified conditions of the earth's surface.

9. That this condition of the earth was not in the carboniferous period favorable to the existence of terrestrial vertebrates, or birds and insects, but eminently fitted for saurians, fishes, and mollusca, and that generally from the knowledge we have of the animal life that existed, no very serious or widespread changes in animal creation took place within the cretaceous period.

10. That while these conditions previously enumerated prevailed, the influences of heat, cold, light, air, water, wind, tides, and all meteorological phenomena generally, were much modified; sub-aerial denudations and the dynamical effects of the elements were different in amount and results.

Geologists have been for over 100 years working on the intricate problems of their science, approximated for the successive ages and periods from the archæan up to the post tertiary, the relative areas of water and dry land that existed in the several periods. If we collate these with the assumption of a globe at first without axial motion, or our present diurnal change, and then this motion successively modified and increased until the tertiary period, we think many geognostic problems might be solved. If we take the tide, for example, whose effect is continuous, irresistible, and ever active, yet we know its power must finally very materially affect the earth's motion, retarding it slowly year by year. Certainly we may not be able to say now how much precisely it does do so for the short period known of human science, yet, as it had once a beginning, so must it necessarily end, or be much modified when the earth's axial motion is finally arrested by it, and the attractive and repelling forces altered by this changed motion.

11. That the hypothesis of a former change in the length of our present day, which is measured by one rotation of the earth on its axis, in no manner disagrees with the Mosaic account of creation. For if we cannot agree upon the occult meaning of his chronology in precise years of time, from the day-dawn of earth, yet this in no manner attacks the truth of his testimony if we can geologically define the period that elapsed before the six days of creation.

12. That the variation of the motion of the earth in the ecliptic, its varying inclination, the eccentricity of its orbit, the effect of the precession of the equinoxes, and the changes which every 12,900 and 25,800 years, as it has been claimed by some scientists, take place from the above causes—changing alternately in the northern and southern hemispheres the length of summer and winter—cannot in amount be great enough to account for the former high temperatures existing in the Arctic regions from the carboniferous to the miocene, tertiary period. If we to-day count our summer from the March solstice to the September solstice, we have 186 days of sun for the northern hemisphere, against 179 days for the southern hemisphere, thus making the southern hemisphere a little colder. But it has been shown that, taking the very highest estimate possible, the difference of seasons that all the above variations of the position of the earth can take would cause a difference of season between the two hemispheres not exceeding thirty-six days in all, and would alternately affect both in the same ratio. This certainly could not be sufficient to transform Greenland and the Melville Islands into a climate like that of Florida or Louisiana to-day.

13. The vegetation of the carboniferous age was rank, dense, and peculiar; probably agreeing with De Candolle's mesothermous type; requiring at least a mean temperature of 66°. This, with abundant moisture, frequent rains, long days and warm nights, would give us the most favorable conditions for the growth of calamites, sigillarias, lepidodendrons, floras, and equisetaceæ so abundant in the carboniferous period.

14. Following this period, and until we reach the cretaceous period, we find but a scanty list of plants and trees in the permian, triassic, and jurassic; the area of water on this globe was largely in excess of land surface. In the cretaceous we find this proportion has decreased some, and that in the Dakota Group, so well elaborated by Prof. Lesquereux in his flora of that group, we find the ancestors of our present forests of oaks, plane trees, magnolias, cedars, yews, sassafras, laurel, poplars, sweet gums, etc., that indicate a growth of trees peculiar to our temperate latitudes south of 38° north latitude, indicating, generally, a temperature of an isotherm of about 60°.

15. That this order of climatic and terrestrial changes extended until late in the tertiary period. We might state it, perhaps, as lasting until the end of the miocene, which in Greenland to-day shows a fossil vegetation rich in oaks, cedars, magnolias, palms, figs, etc. That after this period the revolution of the earth on its axis increased rapidly, the seasons, the length of day and night became more and more pronounced and shortened, cold invaded the more temperate circumpolar lands, the vegetation of high latitudes then either perished or slowly retrograded south and north from their respective polar regions toward the equator.—*Kansas City Review.*

ARCTIC NOTES.

CAPT. S. R. FRANKLIN, U. S. Navy, in charge of the Hydrographic office at Washington, D. C., has published, for the use of the navy department, an account of the Nordenskjöld expedition, accompanied by a chart showing alterations in the Siberian coast line rendered necessary by Nordenskjöld's surveys. The following extract is of interest in connection with the commercial advantages that are expected by the opening of trade with Siberia:

78.—Late publications regarding the expedition entertain sanguine expectations of important results in a commercial way; it is even stated that commerce with the interior of Siberia might thus be opened with the western shores of the United States. A calm review of the narrative of Prof. Nordenskjöld would seem to show that prospects for this are not very encouraging. A comparison of the narrative with the experience of explorers of the Nova Zembla and Kara seas in previous years will make it evident that the Vega happened to hit an extraordinarily favorable year. The trade from Northern Europe to the mouths of the Obi and Jenisei may be profitable enough for ventures, but even on that short route it will require the pilotage of the sturdy Norwegian fishermen and seal-hunters, who are acquainted with the ice of these seas during all stages of the short season. A vessel going to the Lena either way would have to be fully provided for the emergency of being embayed for the winter in the Arctic. If, notwithstanding all this, ventures should be entertained, the following notes may prove of interest and value:

The distance from San Francisco to the Lena is, in round numbers, 3,500 miles, of which 1,000 miles may be considered ice navigation; the distance from the mouth of the Lena to Jakutsk, the first place of commercial importance, is about 850 miles. The river is navigable the entire distance, and much farther, but, owing to shallows, only for vessels of light draught; cargoes would, therefore, have to be transferred at or not far from the mouth of the Lena.

At Jakutsk the river forms a basin, almost four miles in width, studded with numerous islands.

Entire Siberia has a population of 3,440,000 (0·70 to the square mile), Eastern Siberia, 1,514,758; the province of Jeniseisk, 396,783 (0·39 to the square mile); Jakutsk, 236,067 (0·16 to the square mile); and that of Irkutsk, 358,629 (1·16 to the square mile). The town of Jakutsk, with 4,830 inhabitants (1873), has extensive trade as the depot for Eastern Siberia, and is the seat of one of the factories of the Russian American Company. According to Von Humboldt (Cosmos, Vol. IV.), it is probably the oldest town on the globe. The Shergin mine near it shows that the ground is frozen to a depth of 306 feet, thawing in midsummer only three feet. The mean temperature for the year is 13·7° F.; in August the thermometer rises for about ten days to 85°, but from November to February it remains between 42° and 68° below zero. The Lena is frozen for nine months in the year.

Irkutsk, about 1,000 miles S. W. of Jakutsk, at the confluence of the Irkut and the Angara, near the source of the Lena, about forty miles from the Great Baikal Sea, is, next to Tobolsk, the most important town of Siberia, and the seat of government of Eastern Siberia. It has 32,320 inhabitants (May, 1875), and is the principal depot in Siberia for the Chinese caravan trade; it has several fine educational institutions, one of them a military academy and navigation school, an important cloth manufactory, and extensive distilleries. There is great wealth in the larger Siberian towns, and the wealthier classes and the higher Russian officials live in great luxury, which would seem to render trade profitable.

Articles of export to Siberia would be grain, manufactured articles, and colonial products such as sugar, spices, etc.; there might, however, be a sufficient supply of grain from Southwestern Siberia, which is mild and fertile. Articles of import to the United States would be principally mineral ores (graphite) and furs, as also teeth of the antediluvian mammoth (fossil ivory), which have been excavated in surprising quantities from the frozen banks of Lena.

P. S.—Since the above was written, it has been stated in some of the newspapers that two sledge expeditions, sent by the Governor of Eastern Siberia for the relief of the Vega, could not find a trace of her near the reported position, and that the Russian authorities surmised her to be embayed between the New Siberian Islands, where the channels among the latter and between the southernmost and the mainland are not much over thirty or forty miles wide, and therefore easily blocked by pack-ice.

79.—The westernmost positions reached by vessels from the eastward are: That of U. S. S. Vincennes, of U. S. North Pacific Exploring Expedition, under command of Lieutenant, now Rear-Admiral, John Rodgers, U. S. Navy, August 19, 1875, long. 176° 50′ E., where her progress was barred by packed ice, and that of the whaleship Nile, Long, master, August 11, 1867, long. 170° 30′ E., where that vessel was also stopped by the ice. The Vincennes made the above longitude in one day from Behring's Strait, but was fourteen days working back against adverse winds.

A GREAT RIVER CHANGES ITS BED.

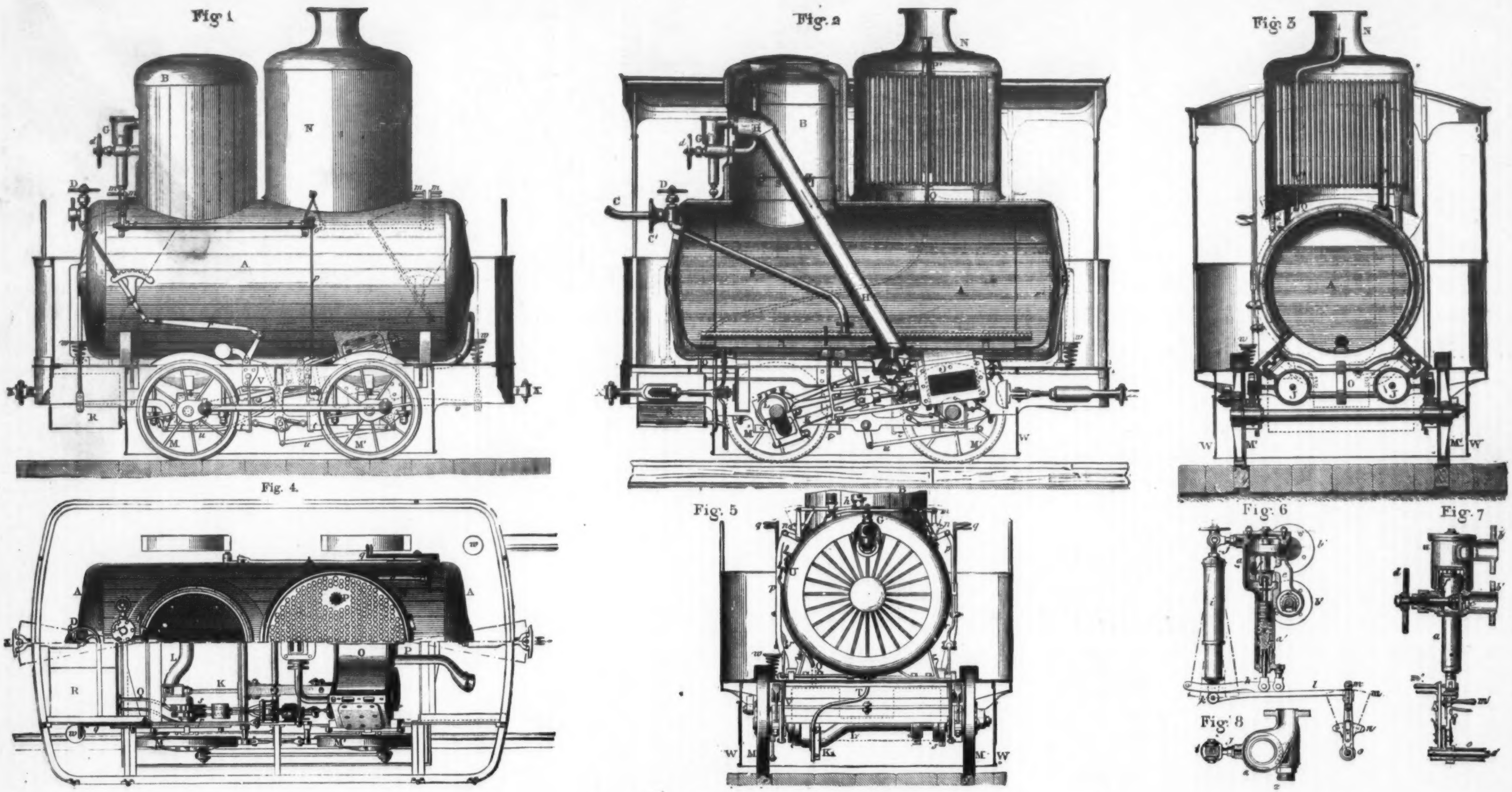
MR. EDWARD CAMPURY, in *Le Devoir*, a Guise weekly paper, says that the late news of the changing of the bed of the Amoo is of very great importance to Russia, and he believes that the phenomenon, far from being accidental, has been effected by Russian enterprise.

The Amoo river is the ancient Oxus over which Alexander the Great led his army into Afghanistan, and which at that time emptied into the Caspian Sea, but which, for some two hundred years, has emptied into the Sea of Aral—a lake, properly, for it is about the size of Lake Huron.

Any one who looks at the map of Asia will see that there is no river flowing into the Caspian on the east except a little stream in Northern Persia, and that the great Amoo river receives all the drain of an immense watershed in Western Turkistan.

The Arab writer, Mokadassi, says that the Amoo once flowed into the Caspian Sea, and that it was displaced by a king of Khiva, who dug a canal to lead some of its waters through the plain of Kharezem into the Aral Sea; that the river, preferring that canal, abandoned its own bed from that time. The Khivan dikes turning the river out of its own bed near Kounich-Ougendi are well known to engineers, also the old bed of the river Oxus, which is even indicated on most maps.

Mr. Campury says: "To-day, either by an accident that Russia should thank its stars for, or more likely through a most skillful Russian maneuver, the Amoo has broken the Khivan dikes and taken possession of its ancient bed. The enormous mass of its water now flows toward the Caspian, thus increasing the length of the river more than 500 kilometers" (310 miles). Peter the Great, according to the same writer, dreamed of turning this river back into its ancient bed, and commissioned Prince Bekowich, in 1717, to study the measures necessary to effect that result. More recently, and at different times, the abandoned bed has been surveyed by Russian officers. It is, therefore, reasonable to suppose that the late rupture of the Khivan dikes is not merely accidental, especially when we reflect upon its significance to Russia and to the development of civilization in Central Asia. Steam navigation will be possible on the new river, and, if not, the Russians will not long delay in making it so, in order that the rich territory lately annexed from Turkistan may communicate with the Caspian Sea. From this to gaining a navigable opening into the Black Sea, either by the Koor river, in the southern valley of the Caucasus, which river extends about nine-tenths of the way, or not far from 300 miles, or by the way of the Volga and the Don, there is but a step. The Volga, which flows into the northwestern part of the Caspian, almost touches the Don about 200 miles from the mouth of the former—that is to say, thirty or forty miles of canal, and the long-sought Russian port on the Black Sea is a thing accomplished.



FRANCQ'S FIRELESS LOCOMOTIVE.

FIG. 1.—LONGITUDINAL ELEVATION OF THE ENGINE.

FIG 2.—LONGITUDINAL SECTION FOLLOWING THE AXIS OF THE RESERVOIR.

FIG. 3.—TRANSVERSE SECTION PASSING THROUGH THE AXIS OF THE CONDENSER.

FIG. 4.—HORIZONTAL SECTION AT TWO LEVELS, SHOWING IN ONE PLACE THE STEAM RESERVOIR AND CONDENSER, IN SECTION, AND IN ANOTHER THE PARTS OF THE MOTIVE MECHANISM.

FIG. 5.—PARTIAL END VIEW OF THE PRESSURE-REGULATING APPARATUS.

FIGS. 6, 7, AND 8.—DETAILS OF THE PRESSURE-REGULATING APPARATUS, DRAWN TO A SCALE DOUBLE THAT OF THE OTHER FIGURES.

FRANCQ'S FIRELESS LOCOMOTIVE.

M. Francq, member of the Society for the Encouragement of Industry, has undertaken to introduce into France the fireless locomotive—a form of engine the practical application of which was first made on the railway between New Orleans and Carrollton, La. The apparatus devised by him and constructed by the Cail works has been doing regular service for several months on the railroad between Rueil and Marly-le-Roy, and has proved a complete success.

GENERAL DESCRIPTION OF THE ENGINE.

A is a cylindrical reservoir of steel plate, containing water which is heated at the time of departure of the train by the introduction of superheated steam; it is surmounted by a cylindrical dome, and both are surrounded by a protecting envelope. This envelope is composed externally of a jacket of wood with a cork lining, and inside of this another jacket of plate. The wood, cork, and plate form a covering, which, while surrounding the reservoir at a certain distance, leaves interposed a protecting cushion of air.

B, a cylindrical dome with a spherical cap, surmounting the reservoir, A, and receiving the steam in measure as it is produced in the reservoir.

C (Fig. 2), pipes through which the steam, furnished by a stationary generator, is led into the reservoir, A. This pipe does not form a part of the engine, but is attached, when it is desired to charge the reservoir, by means of a threaded coupling, C', which unites it with the valve-cock, D. When the charging has been accomplished, the pipe, C, is removed by unscrewing the coupling, and replaced by a screw cap shown in Fig. 1.

D, valve-cock for distributing the steam through the reservoir, A, by means of the conducting pipe, E.

E, conducting pipe which leads the steam to the bottom of the reservoir, A, and lets it escape into the water through a horizontal pipe (Fig. 2) closed at both ends, pierced with a series of small holes, and extending the whole length of the reservoir. To a vertical tube placed at the top of the dome, B, and pierced in its upper part by a certain number of slits through which the steam collected in the dome enters the apparatus, G, and from thence to the working cylinders.

G, pressure regulator, in which the steam that enters by the tube, F, is carried up to the desired degree of pressure before being admitted to the working cylinders. This apparatus, which will be explained further on, is connected by a double opening with the dome, B, and communicates by an elbow with the tube, F.

H, a large inclined conducting pipe, communicating at one end with the pressure regulator, traversing the dome and the reservoir, and ending in the box, I.

I, a box containing a small slide, which constitutes, as in ordinary locomotives, the steam regulator or starting apparatus.

J, working cylinders.

K, cranks connected, as in ordinary locomotives, with the piston rods of the working cylinders.

L, bent motive axle, put in motion by the cranks, K, and carrying the driving wheels, M.

M, driving wheels, coupled with two other wheels, M', which are connected by a straight axle.

N, an air condenser, mounted on the reservoir, A, alongside of the dome. It is composed of a closed vertical cylinder, traversed from top to bottom by 600 tubes open at each end, and is covered by a large bottle-shaped envelope.

O, a box into which the steam passes after acting in the cylinders, J.

P, a tube starting from the box, O, bending around the reservoir, and opening vertically into the condenser, N, and leading the steam into the closed space between the tubes of the latter. A large portion of the steam condenses by contact with the tubes through which cold air circulates, and the water falls to the bottom of the condenser, from which it is conducted by means of the tube, Q, into the receptacle, R.

P', tube for the escape of the uncondensed steam.

R, a receptacle placed under the platform of the engine frame for collecting the water of condensation. It is furnished with an emptying cock, worked from the platform by means of a rod.

S, a metal-plate diaphragm placed at the bottom of the dome, B, to prevent the water of the reservoir, A, being drawn by the steam into the tube, F (Fig. 2).

T, outlet pipe, with blow-off cock, of the reservoir, A (Figs. 2 and 5).

U, three gauge cocks for ascertaining the water level in the reservoir, A.

V, longitudinal and principal parts of the framework upon which the whole engine is supported. This framework rests on the axles by means of ordinary elliptic springs.

W, panels of iron plate surrounding the engine frame, and covering the wheels; in these, windows are cut for the purpose of getting at and oiling the machinery.

X, coupling rods, placed at both ends of the locomotive. One of these rods, in Fig. 2, is represented in section, from which it will be seen that it is composed of two parts, having an interior spring.

THE PRESSURE REGULATING APPARATUS.

The pressure regulator, designated by the letter G in Figs. 1, 2, 3, 4, and 5, is represented in vertical sections by Figs. 6 and 7, and in partial horizontal section by Fig. 8.

a, a double cylinder, the lower diameter of which is less than the upper, and which is united, as explained above, with the dome, B, and the reservoir, A, by a double opening, (Fig. 2). *b*, upper opening of the cylinder, *a*, communicating with the conducting pipe, H (Fig. 2). b', lower opening, communicating by an elbow with the tube, F, which admits steam into the regulator (Fig. 2). *c*, a valve moving horizontally by means of a threaded rod, governed by a hand-wheel, *d*; this is the valve which admits the steam, led by the tube, F, into the regulator. *e*, the canal through which the steam enters the apparatus when the valve, *c*, is open. *f*, a two-seated valve, placed in the upper and larger part of the cylinder, *a*; between these two seats terminates the canal, *e*. *g*, an elongated piston connected by a rod with the valve, *f*, and moving in the lower part of the cylinder, *a*; a portion of this piston is seen in section, and the other in elevation in Fig. 6.

h, a lever articulated at a point at the side of the base of the cylinder and connected with the piston rod, *g*. *i*, a cylindrical box parallel with the cylinder, *a*, and containing a spring; this box constitutes a sort of balance, analogous to those applied to the safety valves of ordinary locomotives. *j*, a fork-headed screw, connecting the box, *i*, with the upper part of the cylinder, *a*. *k*, stirrup with roller, terminating the lower movable part of the spring in the box, *i*; between the branches of this stirrup passes the lever, *h*. The result of this arrangement is, that the action of the spring in the box, *i*, on the lever pushes up the piston, *g*, and consequently keeps the valve, *f*, raised above its two seats. If, then, the entrance valve, *c*, be opened, the high-pressure steam from the reservoir coming through the opening, b', into the canal, *e*, enters the cylinder, *a*, and from thence passes through the opening, *b*, into the conducting pipe, H (Fig. 2); but, on entering the cylinder, *a*, it exercises its pressure on the head of the piston, *g*, and equilibrium being restored by the action of the spring in the box, *i*, the piston is forced to descend again, and, consequently, carries with it the valve, *f*, on to its seats. Consequently, the entrance of the steam is interrupted, and that which has penetrated into the conducting pipe, H, is set free and may go to act in the working cylinders of the locomotive. At the same time that the steam is set free the action of the spring in the box, *i*, becomes predominant, the piston again ascends, the valve, *f*, being open, the high-pressure steam again enters, and so on. The degree in which the steam is freed is regulated by modifying the position of the box, *i*, according to the dotted lines seen in Fig. 6, in other words, by modifying the position of the point of attack of the spring on the lever, *h*. This result is reached by means of the following combination of parts:

l, draw bar of the box, *i*, by means of which this is made to assume at will the different positions indicated by the dotted lines, and which correspond to pressures of 3, 4, 5, 6, and 7 atmospheres. *m*, hand lever for working the bar, *l*. *n*, toothed or notched sector, between which is placed the hand lever, *m*, according to the distance it is desired to draw the bar, *l*.

As the locomotive is not turned around at the termini of the railway, and as it is consequently necessary to have command from two directions over the balance, *i*, as well as the slide or steam regulator of the box, I (Fig. 2), the parts just mentioned, as well as the following, are duplicated at the other end of the engine. *o*, horizontal hollow axles, upon which are mounted the levers, *m* (Figs. 1, 4, 5, 6, and 7); these two axles are put in communication by the movement, o', and are so constructed that the engine man can control the balance, *i*, even when he is at the end of the locomotive opposite to the one at which the pressure regulator is placed. o', solid axles, freely moving within the axles, *o*; these govern the steam regulator of the box, I. m', hand levers for working the axles, o'; they are placed in front of and against the levers, *m*. *p*, vertical rods, connected by cranks with the axles, o', and transmitting the movements of the levers, m', to the regulator of the box, I.

CHANGE OF DIRECTION AND BRAKES.

It being necessary that the command over the brakes as well as that of reversing the locomotive should be exercised alternately at each end of the engine, the mechanism for this purpose is also duplicated; it is, moreover, exactly analogous to that in use on ordinary locomotives.

q, are hand levers with toothed sectors. *r*, draw bars actuated by the levers, *q*, and governing, through lever arms and cranks, the shifting of the grooves on which the four eccentrics, *s*, move. *t*, ordinary shoe-brakes. *u*, rods connected with the brakes, *t*. *v*, pedals actuating the rods, *u*. *w*, disks mounted at the extremity of vertical rods, surrounded by a spiral spring, and connected with the pedals, *v*. By placing the foot on one of the disks, *w*, the brakes press against the wheels, and loosen again as soon as the pressure of the foot is removed, the action of the spiral spring at once raising the disk and its rod. An illustration of the Francq fireless locomotives as they appear on the track in running order may be seen in Scientific American Supplement, No. 159, for Jan. 18, 1879.

SKEW-BEVEL WHEELS.

By Prof. C. W. MacCord.

No. 1.—The Pitch Surfaces, and How to Draw Them.

The form of gearing known as skew-bevel, from the peculiar forms and disposition of the teeth of the wheels, is used for the purpose of transmitting rotation with a constant velocity ratio, from one shaft to another not in the same plane with it, *directly*. That is to say, only two wheels are necessary, one upon each shaft, the teeth of which are in gear.

The rotation is, however, more commonly transmitted *indirectly;* by the introduction of a third shaft, intersecting both the others and carrying two bevel wheels, gearing respectively with wheels upon the first and second shafts. And the use of the skew-bevel wheels is sometimes objected to on account of the greater amount of sliding attending the action of the teeth, as compared with that involved in the running of bevel gearing.

But it is an open question whether this undeniable disadvantage is by any means always so great as of itself to demand the adoption of the expedient mentioned, which introduces the friction of an extra pair of wheels, as well as of the bearings of the intermediate shaft.

In many cases there is reason to believe that the supposed difficulty of laying out the teeth of the skew-bevel wheels has influenced the designer in thus evading the necessity. And it must be confessed that most of the published instructions and explanations in regard to the processes of laying them out, are such that the evasion is not to be wondered at.

It cannot be pretended that these wheels are as simple as bevel wheels, or their teeth as easily constructed, any more than bevel gearing is as simple as spur gearing. But it does appear that the subject has been made, by the manner in which it has been treated, to seem more complicated than it really is; in fact, we have known more than one who was interested in it to be discouraged by the needless obscurity with which it has been surrounded.

By careful study of what follows we believe that any ordinarily expert draughtsman will be enabled to construct the wheels and their teeth in a manner which will satisfy all the requirements of practice. Some of the methods to which we have alluded are confessedly but approximate, and while they may apply in some cases, we have met with those in which they would not answer at all; and other instructions are empirical and radically wrong, so that if wheels made in accordance with them should ever work, it would be in spite of reason and without fulfilling the condition of a constant velocity ratio.

The principles involved in the mode of operation about to be explained are demonstrably correct throughout, and the degree of accuracy attainable in the results depends wholly on the care and skill of the manipulator.

The first necessity is to gain a clear idea of the nature and form of the pitch surfaces. This in the study of gearing of any kind is perhaps best done by imagining the teeth of a pair of wheels to be greatly increased in number and correspondingly reduced in size. It will readily be seen that in spur gearing, as the teeth become smaller the wheels will more and more nearly resemble a pair of cylinders, and that if the above-mentioned process be continued indefinitely, they will finally become cylinders tangent along a right line, the teeth being represented by rectilinear elements of these pitch surfaces. And in bevel gearing it is equally clear that the pitch surfaces will be tangent cones with a common vertex.

In both these forms of gearing it will be observed that the tooth surfaces are composed of right lines, that any two teeth when in gear touch each other along one of these lines, and that this line of contact between two teeth will ultimately, when the teeth are made infinitely small and numerous, become the line of contact of the pitch surfaces.

It will also be observed that when the axes are parallel, the lines of the teeth are parallel and the pitch surfaces are generated by the revolution around each axis in its turn of a line parallel to both. And again, when the axes intersect, the lines of the teeth converge in the point of intersection, and the pitch surfaces are generated by a line also passing through that point, revolving first about one axis and then about the other.

We have now to consider the case in which the axes are neither parallel nor intersecting, and we shall find a relation between the positions of the axes, the forms of the teeth and those of the pitch surfaces, analogous to what has just been pointed out as existing between them in the other forms of gearing. That is to say, the axes are not in the same plane, the pitch surfaces will be tangent along a line not in the same plane with either axis, and the teeth will be composed of right lines, but their surfaces will be warped instead of cylindrical or conical.

The pitch surfaces, then, are formed by revolving about each axis in succession, a right line which is not in the same plane with it. The appearance of a surface thus generated, and the manner of drawing it, are shown in Fig. 1.

The axis being supposed to be vertical and parallel to the paper, the surface is formed by the revolution around it of the inclined line, $a\,b$, also parallel to the paper. As each point of the revolving line describes a circle in a horizontal plane, the determination of any desired number of points in the meridian outline, $k'\,h'\,g'\,p'$, is very easily effected, the method being too obvious to require explanation. The least of these circles will, of course, be that described by the point of $a\,b$, which is nearest the axis, therefore $c\,d$, their common perpendicular, is the radius of the *gorge circle*, as it is called. The meridian outline is a hyperbola, and the surface is called the hyperboloid of revolution.

It will be observed that the same surface will also be generated by the revolution about the same axis, of another line, $l\,m$, whose horizontal projection coincides with that of $a\,b$; these two companion generatrices intersect at d, and are equally inclined to the horizontal plane, but in opposite directions, and $a'\,b'$, $l'\,m'$, are the asymptotes to the hyperbolic outline.

Now, it is clear that the same line, $a\,b$, by revolving around another axis, may generate another hyperboloid, and in order that the two may serve as the pitch surfaces of a pair of wheels, it is necessary that one shall be tangent to the other, all along a rectilinear element.

That this may be the case, the position of the second axis must be such that it shall intersect all the perpendiculars to the common element, drawn from points on the first axis; and this, again, requires that it shall lie in a plane parallel to both the first axis and the common element.

The relative positions of the different lines here mentioned will perhaps be made clearer by the aid of Fig. 2 than it can be by any description.

The upper part of the diagram, as in Fig. 1, is a front elevation, $c\,f$ being the vertical axis, $d\,b$ the revolving line, and $e\,h$ an inclined axis, all three being parallel to the paper in that view; $f\,h$, $l\,n$, $g\,i$, $c\,d$, are perpendiculars to $d\,b$ from points on $c\,f$. The lower part of the diagram, also as in Fig. 1, is a top view, where as before the vertical axis appears as the point, c, $c\,d$ is parallel to the paper, and $d\,b$ appears perpendicular to it, as in fact it is. It will then be seen that by making $e\,h$ in this view parallel to $d\,b$, and only by so doing, the points, e, i, n, h, can be made to lie at once in the perpendiculars, $f\,h$, $l\,n$, etc., and in the line, $e\,h$.

This being understood we can now proceed to the construction of two tangent hyperboloids, which is illustrated in Fig. 3. Representing, as in the preceding figure, the vertical axis by $c\,f$, and the revolving line by $d\,b$, let $c'\,d'$ in the top view be their common perpendicular; this will be the radius of the gorge circle of the vertical surface, which is then constructed as in Fig. 1.

Prolonging $c'\,d'$ to e', let us suppose $d'\,e'$ to be given as the radius of the gorge circle of the second hyperboloid; its axis must then in the top view appear as $e'\,k'$, parallel to $d'\,b'$, and in the front elevation above it must pass through e. In order to determine its inclination, draw through b, the line, $f\,b$, perpendicular to $d\,b$, and prolong it. In the top view this line appears as $f'\,b'$; prolong this to cut $e'\,k'$ in h', which project up to the point h in the prolongation of $f\,b$; then by comparison with Fig. 2 it will be seen that $e\,h$ must be the vertical projection of the axis of the new surface.

This is most readily constructed by making a direct end view of it, as shown, in which $e\,d$ appears as $e''\,d''$ equal to $e'd'$, and $b\,d$ as $b''d''$ perpendicular to $e''d''$. In order to economize in space, the upper halves only of the hyperboloids are drawn in the front view, but it will be obvious that they will be tangent all along $b\,d$, to whatever distance it may be produced in either direction.

Now, if the inclined hyperboloid A be rotated, it will obviously tend to turn the vertical one, B, the directional relation being indicated by the arrows; and we have next to consider the question, What will be their relative angular velocities? When two circles have a common tangent, either in their own plane, like the pitch circles of a pair of spur wheels, or as the intersection of the planes of the circles, like the bases of the pitch cones of two bevel wheels, they roll in contact without sliding; their circumferential velocities are equal, and as the angular velocity is found by dividing the linear velocity by the radius, it follows at once that their angular velocities are inversely proportional to the radii.

Here, however, the case is quite different, and there are some features which at first sight appear contradictory. In the first place, the two circles which work in contact, as for instance the gorge circles, or the circles forming the upper bases, do not have a common tangent; nor is the angle between their tangents everywhere the same, but diminishes as we recede from the gorge planes. Thus, it is clear that $g\,e\,l$ is the angle between the tangents of the gorge circles at e, and that those of the upper base circles at b will include a less angle. And, in the second place, the ratio between the radii of the gorge circle is not the same as that between those of the upper base circles, or those of any other two circles which work in contact.

Nevertheless, it is quite clear that the angular velocity

ratio must be the same throughout; and it can be shown that, in the case here shown, this ratio will be the inverse ratio of $b\,n$ to $b\,m$. That is to say:

ang. vel. A : ang. vel. B :: $b\,m : b\,n$.

These lines, it must be noted, are not the real distances from the point b in space, to the axes. Reference is here made to the vertical projection only, of the two axes and the common element—or more strictly, their projection upon a plane parallel to all three lines.

Having thus projected them, we may take any point as p upon the *projection* of the common element, let fall the perpendiculars, $p\,x$, $p\,y$, upon the *projections* of the axes, and then the angular velocities about the axes in space will be to each other inversely as those perpendiculars.

As no account is here apparently taken of the lateral separation of the axes, this is by no means self-evident; and in order to make the demonstration clear we have drawn the diagram, Fig. 4, to correspond as closely as possible with Fig. 3, with the addition of some necessary lines. The gorge circles only are shown in the top view, since if the velocity ratio be determined as between them, it is known, as above remarked, for the whole of the surfaces.

Now, let us suppose the inclined surface to be moving, as indicated by the arrow, with a known velocity. The linear motion of the point, d, d', in the circumference of its gorge circle may at the instant be represented in magnitude and direction by $d\,l$, tangent to the circle at that point, and, therefore, seen in its true length, and perpendicular to $d\,h$, in the front elevation.

It is obvious that if this point were moving in the direction of the line, $d\,b$, it would simply slide along the vertical surface without tending to turn it.

The actual motion, $l\,d$, is not wholly in that direction, but it may be resolved into two components, $d\,o$ and $d\,r$, of which the latter is in that direction, and is, therefore, ineffective.

The other, or *normal* component, perpendicular to $d\,b$, the element of tangency, does, however, tend to impart rotation to the vertical hyperboloid. And the motion of d, d', considered as a point of that surface, may at the instant be represented by $d\,g$, tangent to the circle which d, d', describes about the vertical axis; $d\,g$ being the resultant motion, of which $d\,o$ is the normal component, $d\,s$ will be the other component in the line $d\,b$.

Now let

v = ang. vel. of inclined surface.
v' = " " " vertical "

then, since ang. vel. $= \dfrac{\text{lin. vel.}}{\text{rad.}}$, we shall have

$$\left.\begin{aligned} v &= \frac{d\,l}{d'\,c'} \\ v' &= \frac{d\,g}{c'\,d'} \end{aligned}\right\} \therefore \frac{v}{v'} = \frac{d\,l}{d'\,c'} \times \frac{c'\,d'}{d\,g} = \frac{d\,l}{d\,g} \times \frac{c'\,d'}{d'\,c'}$$

But the triangles $d\,l\,g$, $d\,f\,h$, having their sides respectively perpendicular to each other, are similar, whence $\dfrac{d\,l}{d\,g} = \dfrac{d\,h}{d\,f}$. And also, $\dfrac{c'\,d'}{d'\,c'} = \dfrac{c'\,b'}{b'\,h'} = \dfrac{f\,b}{b\,h}$,

so that $\dfrac{v}{v'} = \dfrac{d\,h}{d\,f} \times \dfrac{f\,b}{b\,h} = \dfrac{d\,h}{b\,h} \times \dfrac{f\,b}{d\,f}$.

But $d\,b$ is perpendicular to $f\,h$; whence, drawing $b\,m$ perpendicular to $d\,f$, and $b\,n$ perpendicular to $d\,h$, the triangles $d\,b\,f$, $d\,b\,m$, will be similar, and so also will the triangles $d\,b\,h$, $d\,b\,n$; and we shall have

$$\frac{d\,h}{b\,h} = \frac{d\,b}{b\,n}, \text{ and } \frac{f\,b}{d\,f} = \frac{b\,m}{d\,b};$$

whence, finally,

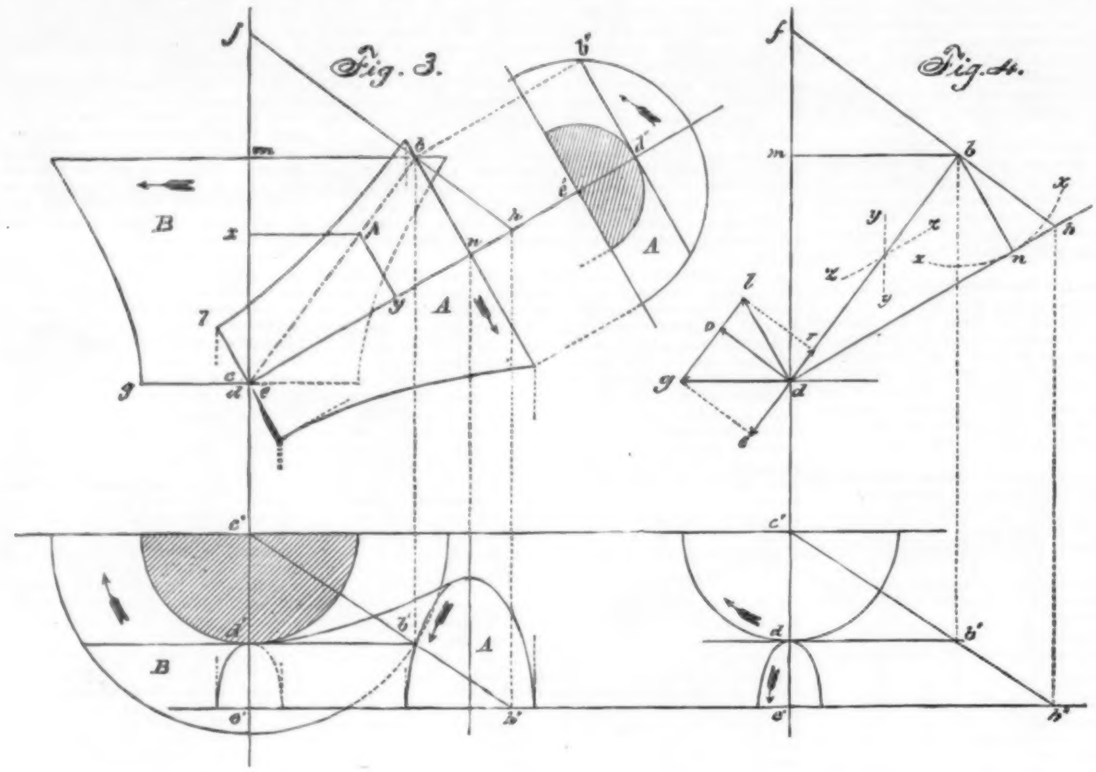
$$\frac{v}{v'} = \frac{d\,b}{b\,n} \times \frac{b\,m}{d\,b} = \frac{b\,m}{b\,n}, \text{ as stated.}$$

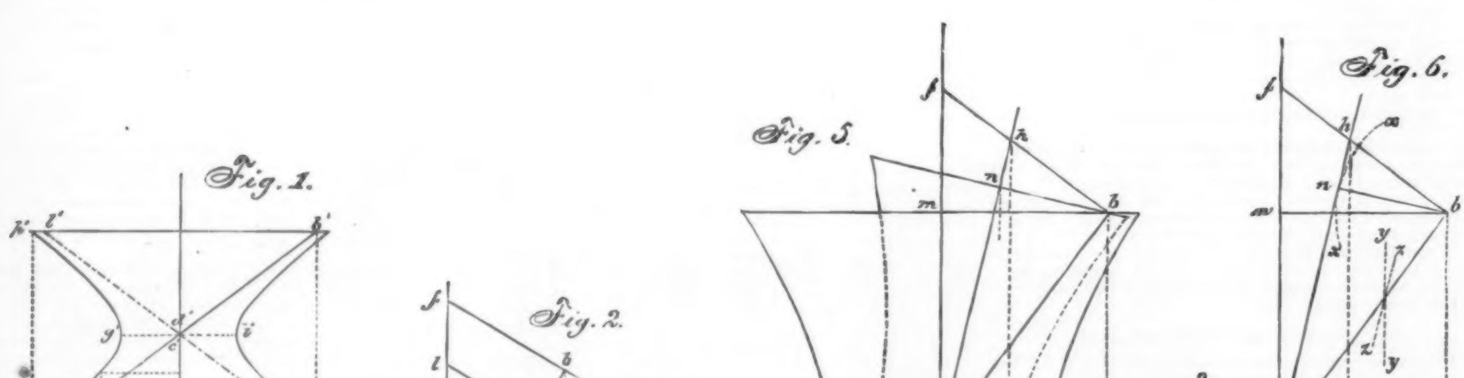
If then, the vertical hyperboloid being given, it be required to construct the inclined one so that it shall work with the first with an assigned velocity ratio, we may proceed thus. Having drawn, in Fig. 4, the vertical projection of the first axis, $d\,f$, and also of the generating line, $d\,b$; from any point, b, in the latter draw $b\,m$ perpendicular to $d\,f$, and also through b draw $f\,b$ perpendicular to $d\,b$, and prolong it indefinitely. About b, with a radius, $b\,n$, whose magnitude is to that of $b\,m$ in the inverse ratio of the assigned velocities, describe the arc, $x\,x$, tangent to which draw $d\,n$, and produce it to cut the prolongation of $f\,b$ in h; then $d\,n\,h$ is the vertical projection of the required axis.

In the horizontal projection, c', and $d'\,b'$, are given; draw then $c'\,b'$ and prolong it indefinitely, project h to h' in that prolongation, and draw $h'\,c'$, the horizontal projection of the new axis, parallel to $d'\,b'$.

It usually happens in practice that the axes are given in position, and the draughtsman is required to make the wheels so that they shall work with an assigned velocity ratio.

Supposing this to be the case, draw in Fig. 4 both pro-





SKEW-BEVEL WHEELS.—BY PROF. C. W. MACCORD.

jections of the two axes; that is to say, df and dh in the vertical projection, c' and $e'h'$ in the horizontal projection. Draw in the former, yy parallel to df, and zz parallel to dh, at distances from those lines inversely proportional to the angular velocities of the surfaces of which they are the axes. Through p, the intersection of yy and zz, draw db, the vertical projection of the common element; and through any point b of db draw fb perpendicular to it, producing it to cut dh in h. Project h to h' on $e'h'$, draw $c'h'$, and project b to b' on this last line; then through b' draw $b'd'$ parallel to $c'h'$, and it will be the horizontal projection of db, the required common element, from which the two pitch surfaces are constructed, as in Fig. 3.

What has thus far been said relates only to the case in which the hyperboloids are externally tangent to each other. But if one be larger than the other, the smaller may be placed within it, and that in such a way as to touch it along a line of the concave surface, exactly as a small cone may be internally tangent to a larger hollow one. And it is essential that this case also should be clearly understood, for, as will subsequently appear, it will be necessary in laying out the teeth of these wheels to construct a hyperboloid thus internally tangent to each pitch surface, and rolling with it with a given velocity ratio. For this reason we have in Fig. 5 shown the same hyperboloids as in Fig. 3, but with the second or inclined one internally tangent to the vertical or inclined one. In connection with this is given also the diagram, Fig. 6, corresponding to Fig. 4, and similarly lettered, from which it will be seen that the deduction of the velocity ratio is not affected by the new relative portions of the surfaces and their axes.

But it will be observed that, supposing as before the vertical surface and the velocity ratio to be given, the position of the second axis is determined by drawing dh tangent to the arc, zz, on the opposite side from that selected in Fig. 4.

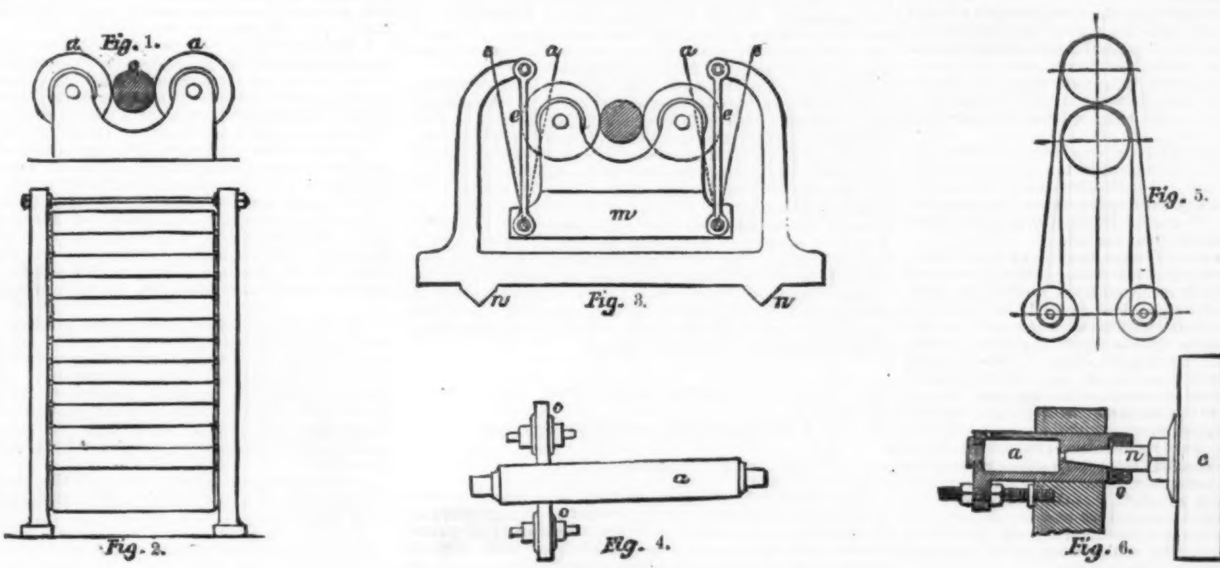
And also, that in the case in which the two axes and the velocity ratio are given, the line, zz, is drawn parallel to dh, as in Fig. 4, but on the opposite side, for the determination of the point, p, in the common generatrix.

This will call attention to the fact that this case always will admit of two solutions; in other words, where the axes are given in position, two pairs of hyperboloids may be constructed, having the same velocity ratio, but opposite directional relations. We have purposely selected such conditions that one of these pairs presents the case of internal, the other that of external, tangency.

It will be found that in every instance one pair will be externally tangent, as in Fig. 3, but it does not follow, nor is it true, that because the directional relation of the other pair is different the phenomenon of internal tangency will occur; a matter to which we shall have occasion subsequently to refer more at length.

It will be observed that the action of these pitch surfaces consists in rolling, combined with a sliding, in the direction of the common element. Thus, referring to Fig. 4, if the two points in contact at d, d', both moved wholly in the direction, do, with the velocity represented by that line, there would be perfect rolling contact. But that motion of the point in the vertical surface has combined with it a motion, ds, and that of the same point in the inclined surface has combined with it a motion, dr. Both ds and dr lie in the line db, whose horizontal projection is $d'b'$, that is to say, in the line of the common element; and in this case their sum, rs, represents the velocity of the sliding of the surfaces along that line, corresponding to the linear velocities, dl, of the inclined gorge circles, dg, of the one belonging to the vertical hyperboloid; in Fig. 6, rs will be the difference between ds and dr, which there have the same direction.

These pitch surfaces, then, do not *roll* together with absolute perfection, as do the pitch cylinders and cones of spur and bevel gearing; and, of course, there must be a still greater amount of this sliding between the teeth of the complete working wheels. But in either of the other kinds of gearing there is a certain amount of sliding friction between the teeth, and, as before remarked, it may be doubted whether the difference in this respect between a pair of conical and a pair of hyperboloidal wheels is in many cases equivalent to the extra friction of a second pair of the former, with that of the bearings of an intermediate shaft. Besides, it is easy to see that circumstances may render the introduction of such a shaft very inconvenient, if not wholly impossible. We shall, therefore, in our next, proceed to the consideration of the tooth surfaces of these wheels, and the explanation of a practical method of laying them out.



CALENDER ROLL GRINDING.

HOW CALENDER ROLLERS ARE GROUND.

WHAT is called the "Poole system" is a method of grinding especially applicable to calender rollers, invented by J. Morton Poole & Co., and extensively carried on in their works at Wilmington, Del., and introduced in England, says *Engineering*, by Umpherston & Co., of Leith. It is a common thing for even skilled engineers to examine the operation of the Poole machines, and go away without understanding the principle on which they act. The operation is in fact one of the most intricate imaginable, and has perhaps no counterpart in mechanical manipulation. This we deem proper to mention at the beginning, so as to invite close attention to the description and diagrams, which at best must be an imperfect means of explaining a process wherein some of the most intricate points consist in the running action of the machines.

In the Poole system of grinding, the first thing to be pointed out is the use of two emery wheels, one at each side of the work, as shown in Fig. 1, where *a a* are grinding wheels, and *e* a roller to be ground. The two wheels, *a a*, are mounted in one frame, and positively connected together, so that in effect they become a "pair of calipers," producing a positive parallelism of the roller, *e*, unless the wheels should wear away as they traverse from end to end, a matter scarce supposable, because the traverse motion is quite rapid, and the wheels employed are of the hardest corundum that can be obtained.

It will be obvious that true parallelism must result from the fixed distance between the two wheels so long as both are cutting, but the straightness of the rollers, which is an equally important condition, must at the same time be secured. Calender rollers for the finer kinds of paper are made from 6 feet to 7 feet long, and in nests or piles of from 3 feet to 12 feet in height, as shown in the diagram, Fig. 2; in some cases as many as eighteen have been mounted in one pile or stack, the number used depending on their truth. The straightness must be absolute, or within an inappreciable limit, otherwise the thinner kinds of paper in passing through would be pulled, and distorted by unequal tension and irregular compression. The limit of variation we are not able to fix, but imagine that $\frac{1}{1000}$th part of an inch in 6 feet would not be admissible.

This straightening is secured in the Poole system of grinding by mounting the two wheels on a massive swing frame poised on knife edges, as shown in the diagram, Fig. 3. The weight of the frame is to prevent oscillation from sudden resistance, and thus secure a steady uniform motion of the wheels; and the sensitiveness to pressure is increased or diminished as the work may demand, by shifting the top pivots to different angles, as shown by dotted lines. If the links, *e*, are set at an angle, as indicated by the lines, *a a*, the swinging motion becomes more sensitive, but if moved to the position shown by lines, *e e*, it will require more pressure to move the frame, *m*.

The rollers when first mounted, even after careful turning, are never truly cylindrical, and the first operation is to fasten the pivoted carriage, *m*, so that it cannot move transversely, and then grind the roller until it becomes cylindrical, as true as the ways at *n* will determine. Then the carriage is loosened, and the straightening process begins, and it is here that we come to that intricate point in the Poole process on which its importance mainly rests, and which has before been alluded to as difficult to explain.

The absolute straightness of the rolls, independent of the ways on which the swing-frame carriage runs, seems a paradox. The fact is, of course, indisputable, thousands of rollers having been ground to perfect truth, and five independent machines operating before one's eyes is evidence enough so far as fact; but the principle on which the swinging carriage determines a straight line will still remain a kind of mechanical puzzle.

Let it be supposed, looking at diagram, Fig. 4, that the roller, *a*, is crooked, even to a minute degree, then the result must be that either the convex side will be ground off by the wheels, *o o*, or else the heavy swing-frame, shown in Fig. 3, must vibrate back and forward to the extent of the "crook" at each revolution of the roller. This latter can easily be imagined as impractical, and any other result must be a tendency to straighten the roller as rapidly as it could be ground away, and wholly independent of the parallel grinding ways beneath the carriage; perhaps a proper statement of what takes place will be that the rotary axis of the roller becomes a guide for the swing carriage. The rotary axis of a revolving body is, of course, a line of absolute truth if flexion is not considered, and as any bending of the roller from its weight would be in a vertical plane, the movement of the swing-frame is not affected in this way, so that movement in an absolute straight line is the result. The rollers require to be not only straight but parallel, but in respect to this last requirement there need be no comment. Two wheels with their axes positively connected must produce parallelism in whatever is ground between them.

The sensitiveness of the swing frames on which the wheels are mounted is such that even the slightest touch will cause one wheel to cut more than the other, and in moving up the wheels, or feeding as it may be called, the handles of the screws are struck lightly with a light mallet of soft wood, care being taken that the blows, slight as they are, shall be given at right angles to the screws and transverse to the swing motion.

Some readers will, no doubt, be led to inquire why these sensitive devices are not disturbed by the stress of the bands which drive the emery wheels. This will be understood from Fig. 5, which shows the manner of arranging the bands, of which there are two for each wheel, that is, four to a machine.

We have now said as much as circumstances will permit to be explained in respect to the Poole process of grinding. There are to be seen throughout the very complete works at Wilmington many things pertaining to grinding which are special and peculiar, matters apparently of but little import and yet to the experienced suggesting experiments and expense. The process with which we have been dealing is now carried on in Germany and in Great Britain, and its value to the paper-making interest has been very great, both in a mechanical and economic way. Great accuracy has been secured, and the expense of making such rollers at the same time reduced.

This system of grinding has been described at some length to show how a large and important industry has grown out of improvements in grinding processes, made within ten years past, but there is no purpose of recommending, except in rare cases, the substitution of grinding for cutting operations in metal working.

There have been many mistakes made in attempting to supersede tool cutting by emery grinding in operations affording no reason for such a change, and it is common to meet with engineers or skilled mechanics who will speak of the two methods of shaping and cutting material as though they were rival processes applicable to the same purposes. Perhaps one of the best illustrations that can be given of the difference will be to repeat a remark made by a shrewd practical mechanic not long since in respect to grinding. He said: "It consumes power enough to remove metal in chips, let alone pulverizing it at the same time."

There can be no question that for shaping any metal soft enough to cut with edge tools, that process is economically the cheapest, and as a rule the larger chips cut away the less is the power consumed proportionately. The time and expense will also be found to follow approximately the same ratio. Grinding processes, paradoxical as it may appear, seem to be suited for the rougher kinds of shaping where exact dimensions are not essential, and for the finer kinds of shaping where exact dimensions are indispensable. As before pointed out, it may be called the first and last among metal shaping processes, and by analogy represents the two extremes in respect to exactness.

The flying dust from emery wheels, which constitutes one of the most serious objections to their use in engineering shops, can be almost wholly avoided by water grinding or pneumatic fans; in many cases where there would be difficulty in using water on the work dust can be avoided by setting a vessel of water beneath the point of contact, so that the dust and sparks will be thrown into the water and collected there. This little precaution, which costs nothing, can be applied to all kinds of cylindrical grinding, and should never be neglected.

The steadiness of motion in emery wheels, on which their proper working depends, requires great care in balancing all parts, also in respect to bearings and driving-bands. The diagram, Fig. 6, shows a method of mounting the bearings of emery wheel spindles, which has given satisfaction in some cases, and is quite inexpensive. The large chamber, *a*, at the back is filled with some kind of lubricating paste, which will melt at a low temperature, and the smaller chamber at *e*, next to the wheel, *c*, is filled with fibrous packing, loosely pressed in around the spindle at *n*. This prevents flying emery dust from finding its way into the bearing, and as the flow of spent oil is outward through this packing nothing is by that means carried into the bearing. Hardened steel running on cast iron is perhaps as good as any combination that can be used for such bearings. Softer metals, such as brass and white alloys, "hold" the emery dust, while close-grained cast iron permits it to work out with the oil.

TO REMOVE GLASS STOPPERS.—Hold the neck of the bottle in the steam from the spout of a tea-kettle, and keep turning it round and round so as to heat the neck equally. In a minute or two (sometimes less) the stopper can be removed with ease. When the neck of the bottle is thick, the heat must be applied more gradually than when the bottle is a thin one.

HORSE-SHOEING.

By D. E. SALMON, D.V.M.

THAT horse-shoeing, as it has been practiced in this country, is responsible for a large proportion of the lamenesses by which our horses have been afflicted is not to be doubted; but that the form of shoes most commonly used, or the application of these, is essentially and radically wrong, is a point yet to be proved. Unless I am much mistaken, it is not the fault of the shoes, nor, indeed, of the *necessary* operations of shoeing, that causes so many deplorable results; but, on the contrary, it is the unnecessary cutting and rasping; it is the failure to have the shoes removed, and the excess of horn pared away at sufficiently frequent periods; it is the ridiculous variations given to the common shoes—in short, it is sheer ignorance of the functions of the different parts of the foot and the proper ways to assist them that alone causes the evils so much deplored.

Of late we have had a multitude of teachers, through our agricultural and even our religious press, who have sought to impress on our minds the great need of a revolution in our shoeing practices. With scarcely a smattering of anatomical and physiological knowledge, these men will lay down their opinions as though they were giving expression to the most firmly-grounded scientific principles; and they point out the changes which must be made in our present system, and support them with an array of assumed facts calculated to carry conviction in the minds of those who have no means of verifying their conclusions. Too often these humanitarians are more interested in the sale of a patent shoe than in the diffusion of useful knowledge, and too often their teachings are such as to intensify the defects of the present system instead of removing them.

No foot, no horse, is a saying as true as old; and one of the most important considerations in preserving our horses is to keep their feet in a healthy condition. To do this, we must know something of their structure and functions; and to teach these points effectively, at present, it is necessary for us to grapple with some of the absurdities that are now being so persistently pressed upon public attention. It is claimed by some, and the reproach has several times been cast at the writer, that the proper way to teach truth is to record our facts and opinions, and not combat those of others: but it seems to me this is to increase confusion, for how can the mass of people discriminate between assumed facts and those which are well-founded; or how can they detect the flaws of argument, the hasty opinions, the false conclusions, which are only apparent to those who are well versed in that particular subject?

In this, as with some other subjects, then, we shall attempt to make the exposition of fallacies a part of our method of teaching truth. Where we see great harm being done to our agriculturists, by wrong statements and false conclusions, we shall not hesitate to expose them, no matter who the author may be; and we have no fears in granting others the same liberty in criticising us that we take with them.

The true object of shoeing is to protect the foot from excessive wear without interfering with the functions of its parts; this is the aim and *end* of the shoer's art. Of course, in this statement, pathological conditions are excepted, because each of these needs special treatment, to be indicated not by the shoer but by the veterinarian.

A recent writer, who contributes largely to horse literature, has lately been writing a sort of shorter catechism about the horse's foot, which, from its author's profession, might be considered a reliable compilation at least, but which in reality is a rehash of all the ridiculous ideas and harmful practices which one meets with in sporting circles, stables, and blacksmith shops. The leading ideas of this are, that the horse's whole weight comes upon the sole of the foot; that the office of the frog is to expand the foot and to support the tendons and navicular bone; and, finally, that the foot naturally perspires or sweats, and that the prevention of this perspiration by scaly formations on the sole is a harmful condition. As deductions from these *assumed* facts, we are told that the foot must have a bearing over its entire surface, there must be frog pressure, that the sole drops or becomes bilged because it does not have proper support from beneath, and that to cure this condition a gentle but steady pressure is to be used, that will gradually and painlessly force it up and back to its proper position.

Now, every one of these statements is utterly opposed to the physiology of the horse's foot, which has been established by years of careful investigation by the most talented members of the veterinary profession. The weight of the horse does not come upon the sole, but is suspended by a wonderful arrangement of fibrous tissue, which unites the bone of the foot to the inner surface of the hoof-wall; and the proof of this is, that the sole may be, and often is, removed with impunity, without the bones descending a particle lower than before. More than this, when from inflammation of the laminæ, which unite the hoof-wall and coffin bone, these are weakened and partially detached, so that the bone is allowed to descend and a part of the weight to come upon the sole, the feet become tender, and the sensitive tissues are bruised between the sole and bone; the sole, in such cases, is unable to keep its normal position, whether the animal is shod or not, but drops and becomes bilged or convex; and any effort to counteract this by pressure inevitably results in bruising the sensitive tissues immediately above the sole. Now, these are facts—not assumed, but the experience of the veterinary profession, recorded in its standard works, and confirmed almost daily by practitioners.

Again, the office of the frog is not primarily to expand the foot, but to protect the sensitive tissues. The expansion of the hoof, if it serves any useful purpose at all, is to allow the lateral expansion of the plantar cushion (elastic frog), and thus prevent its being crushed and bruised between the descending bones and the horn. Even the horny frog is a soft, elastic body, suited to give way readily when it receives pressure from above. When the foot comes to the ground, the bones have a downward and backward movement which compresses the plantar cushion, and this being an elastic body, transmits the pressure in all directions; it is here that the yielding nature of the frog is most useful. Descending before the pressure which it receives from the sensitive cushion, it prevents this from being injured, as it assuredly would be if compressed between unyielding substances. Of course in descending, the frog tends to exert a lateral pressure, which assists the sensitive tissues in causing dilatation of the hoof-wall. But the essential object is not to dilate the hoof-wall—for this of itself is of no consequence—but rather to allow the downward and lateral movement of the sensitive tissues, and prevent their injury by being compressed between two hard substances.

It is just here that our amateur veterinarians make their great mistake. Confining their attention to the dilatation of the hoof-wall, they forget its object; they bring pressure to bear upon the frog, in order to expand the hoof-wall, not knowing that in doing this they are producing the very condition that should be avoided. The descent of the frog is much more evident in the natural condition than the expansion of the hoof-wall, and it is this chiefly that prevents the crushing of the sensitive tissues when the bones descend; and any pressure on the frog by destroying this function, especially in fast gaits, when it is most needed, must have disastrous consequences.

But this teacher claims for the frog another function, viz., to support the tendons, and particularly the navicular bone, which, as he says, "receives its sole support by the pressure of the frog." Then the great perforans tendon, which plays under the navicular bone, is no support. The ligaments which bind the navicular bone to both the lower pastern and coffin bones are no support. Such an idea could never be entertained by any one acquainted with the structure of the part. The joint between the lower pastern and coffin bones is almost identical with the fetlock joint in its mechanism; the navicular bone serves as a sort of pulley for the perforans tendon, just as the sesamoids do in the latter joint. It is the strong ligaments and their most ingenious arrangement that prevent the bones from descending at this joint, not the pressure or support which they receive from the frog. Otherwise, how could the similarly-arranged fetlock joint be maintained without pressure from below?

That the tendon needs no support from below is very evident. Composed as it is of white, fibrous tissue, inextensible, of great strength and extraordinary size, attached to the muscle at its upper extremity, receiving a re-enforcing ligament behind the cannon which gives it a point of support on the bones of the knee and hock, strengthened again below the navicular bone by a strong, fibrous sheath, and by branches passing upward, which unite it firmly to the upper pastern bone, and finally, firmly united to the coffin bone, it is a structure formed to support and not to be supported. It is one of those remarkable arrangements of which we find so many in the animal economy, showing the most consummate adaptation to the end required; and that end is to prevent the undue descent of the bones at these joints as well as to flex the pastern and foot. If we deny this office of supporting these joints to the tendon, then the strong metacarpal ligament, the strengthening sheath beneath the navicular bone, and the upward branches of the tendon at the same point are useless structures, created without a purpose, and existing without a reason; but this office cannot be successfully denied, for the frequency with which these re-enforcing ligaments are sprained is sufficient evidence that they are used. And if the tendon needed further support, an elastic cushion giving way before the slightest pressure, and surrounded by dilatable horn, would hardly have been the structure furnished for such a purpose.

There is no longer room for doubt in regard to the frog pressure theory; it has been disproved both theoretically and practically. Even Coleman, with his learning and unmistakable genius, was unable to give more than temporary life to it, though his shoes were largely adopted by the London shoers, and given a fair trial in the English army. His patent shoes with an artificial frog set upon a spring to insure frog pressure with all animals, were received with the greatest enthusiasm; but how soon they were discarded! Not only were they useless in preventing or curing contracted feet, but they were productive of positive injury. There is no use to persist, gentlemen, in teaching such nonsense. These ideas are fully half a century behind the times; and it is a disgrace to the intelligence of the American people to have our press filled, in this enlightened age, with such rubbish.—*Scientific Farmer.*

THE PHOTOCOLLOTYPE PROCESS.

By T. BOLAS, F.C.S.

THE subject of collotypic printing is one which should be of the greatest interest to every student of photography; and to the photo-mechanical enthusiast the collotypic process carries with it a peculiar charm, arising not only from the great degree of control which the operator has over the result, especially during the inking of the plate, but also from the simplicity of the whole process and the small amount of apparatus required for working it.

In careful hands the best collotypic processes are capable of yielding results equal to the finest work of the silver printer; while the collotypic operator has the advantage of being able to print in any color on almost every kind of paper, and he can produce prints either in even gradation of tone or in a stipple of any required degree of fineness. Moreover, the silver printer can never be sure of turning out even fairly permanent prints, while the collotyper has this matter quite in his own hands. There can be but little doubt that when the collotypic methods shall have been made the subject of as much study, labor, and thought as have been expended on the ordinary wet collodion process, complete success in collotypic printing will be in the hands of every one who has sufficient intelligence to master the negative process.

The general principles of collotypic processes are as follows: A film of bichromated gelatine, either attached to a support or not, is exposed to light under a negative. Under these circumstances, those parts of the film acted on by the light lose their power of absorbing water, this change being partial or complete according to the extent to which light has acted on the sensitive gelatine. The exposed film is now sufficiently soaked in water to saturate and swell those parts able to receive the moisture, when it is wiped and inked by means of a roller charged with a fatty ink. Under these circumstances the exposed or unswelled parts of the film take up ink from the roller, and as the amount of ink which becomes adherent to each part of the film is proportional to the degree of exposure a perfect picture in half-tone is the result. A sheet of damp paper being now laid on the film and pressure applied, this picture sets off and forms a print on the paper.

Before entering into a description of the working details of collotypic printing processes, it may be well to take a cursory glance at the salient features of the principal methods which have been proposed.

The earlier collotypic processes, as put forward by Poitevin, Maréchal, and others, consisted in drying a layer of bichromated gelatine on glass or metal plates, no substratum being employed. The film being now exposed to light, and inked, impressions were printed on paper in the ordinary lithographic press. Under these circumstances the film possessed but little stability, and was liable to be either damaged or partially removed from the support after a few impressions had been printed. This result arose partly from the fact that water penetrated between the rigid support and the film, and partly from an undue softening of the film itself. Attempts were made to secure a more perfect adhesion of the film to metal plates by the addition of mercurial salts and other substances to the gelatinous preparation. The result of this was a local decomposition in that part of the film next the metal; and this decomposition led to an insolubility of the deeper layers of the gelatinous film, so that the infiltration of water between the film and the plate was prevented. The results attained by such methods were not, however, of the first order.

Subsequent modifications in the collotype process have, for the most part, been made with the view of securing a more perfect adhesion of the gelatine pellicle to the support, or of hardening the gelatinous film itself.

Waterhouse coats a finely-ground and leveled glass plate with a mixture consisting of 750 parts of water, six of soap, two of tannin, and one hundred of gelatine. The film having become dry, the plate is sensitized in a four-per-cent. solution of potassium bichromate. The plate being once more dried the film is exposed under a negative, after which the back of the plate is exposed to light for a few minutes, so as to render that portion of the film which is in immediate contact with the glass so insoluble as to resist the action of water; and this insoluble portion of the film acts as a substratum while the printing portion of the film is hardened by the tannin originally added to the mixture.

Borlinetto introduced a process in which the plates were albumenized much in the same way as if it were intended to take collodion negatives on them. This having been done, an alcoholic solution of silver nitrate was employed to make the albumen film insoluble. The plates were next washed and dried, after which they were ready to be coated with the film of bichromated gelatine. This method answers very well, and the preliminary albumenization of the plate is a feature of considerable importance.

The essential feature of Albert's process consists in covering the glass plate with a thick layer of a preparation consisting of albumen, gelatine, and potassium bichromate. When dry this film is exposed to light through the glass plate, so as to make those parts insoluble which are in immediate contact with the glass. This having been done, the plate is washed in warm water so as to dissolve away the surface portion of the film, leaving the insoluble part adherent to the glass plate. This insoluble part of the gelatino-albumen film serves as a substratum for a bond of union between the glass plate and the actual printing film, this latter being now put on the plate. This process of Albert has been extensively and successfully worked by many firms in Europe and America.

A process known commercially as the "heliotype" has been introduced by Edwards, and its essential feature consists in the use of a free film of sensitive gelatine, which is exposed under a negative, and after having been soaked in water is squeegeed down on to a metal support, when the inking operation is performed by means of a roller.

The method of working which now appears to offer the greatest promise for the future is that of Husnik, and the process of this experimentalist is now being very successfully worked under various names. Husnik first coats the plates with a substratum composed of albumen and water glass. This, having been allowed to dry, is washed to remove the soluble matter, after which the plate is coated with the actual printing film, which adheres well if reasonable precautions are taken in the working of the process.

Among the curiosities of collotypic printing may be mentioned the method of Delaunoy. A carbon print is embedded in a mass of soft gelatine, sufficient glycerine being present to prevent the gelatine from becoming dry. An inky roller being applied, the insoluble gelatine of the carbon print holds the fatty ink while the soft ground rejects it. An impression can now be taken from the surface by squeegeeing a piece of damp paper against it, no press being required.

In the subsequent articles such of the above collotypic processes as are adapted to the requirements of the present time will be considered in detail.

Probably the principal circumstance which has prevented photographers from taking up and working the collotypic processes arises from the trouble connected with the use of the ordinary lithographic inking rollers, especially when they are only required occasionally. In order that a collotypic plate may be satisfactorily inked it is absolutely essential that the roller should be in first-rate condition, and when the roller has been got into good order by some weeks of preparation, it can only be maintained in a fit state for work by being kept in tolerably regular use, and this involves the expenditure of much time in scraping, cleaning, and so forth. The disadvantages connected with the ordinary lithographic rollers have lately been overcome by Mr. Lanham, of 75 Fleet street, London, who has introduced a roller made of red vulcanized India-rubber, which has important advantages over the ordinary leather roller. Lanham's rollers are always in working order, as the ink merely rests on the surface, and they can be cleaned in a few seconds by means of a rag moistened with turpentine, after which they may be stored away without any danger of hardening or deterioration. For collotypic printing these rollers possess special advantages, as the ink can be entirely removed in a few seconds, and may be replaced by another sample of different consistency. Again: these rollers are worked to almost mathematically-true shapes by self-acting shaping machines, and the surface is much finer in texture than that of the best leather lithographic rollers; the consequence is that collotypes can be produced with these rollers so as to be almost free from any trace of grain or stipple.

The writer of the present article recently introduced to the notice of an audience at the Society of Arts a roller which consisted of a body made of the usual glue and treacle composition employed by typographical printers, covered with an India-rubber casing. By varying the composition of the glue and treacle composition rollers of any required degree of hardness could be obtained—an advantage of importance to the collotypic printer. Notwithstanding this, the effects of variations of temperature were more or less fatal, and it was difficult to prevent these rollers losing their shape in warm weather. Mr. Lanham has, within the last few days, patented and worked out a very simple and ingenious plan for attaining a similar end. The portions of the India-rubber lying between the central core or stock and the surface are perforated, or honeycombed, the number, position, and shape of the holes depending on the degree of softness required in the roller. More will be said regarding these rollers and their management when the operation of inking the collotypic plate is considered.

NATIVE BITUMENS AND THE PITCH LAKE OF TRINIDAD.*

By W. O. CROSBY.

MINERAL pitch and the most of the native bitumens have been known from very early times. Among the ancient writers we find many statements indicating not only a knowledge but a practical use of these substances: and it is known that asphaltum was applied to architectural purposes more than four thousand years ago. That this substance was held in high estimation may be inferred from its being ranked by those writers among the best building materials of those ages, and from its application to structures requiring great solidity and permanence.

It is mentioned at several places in the Bible under the name of slime and pitch: Noah, in building the ark, being commanded to "pitch it within and without with pitch," while we read that the bulrush ark of the infant Moses was "daubed with slime and with pitch." Herodotus says it was used as a cement in building the strong walls of Babylon, large quantities being brought down to the Euphrates by the small river Is. These fountains of Is, celebrated as having attracted the attention of Alexander the Great, Trajan, and Julian, still continue to pour out inexhaustible supplies. The same author describes the mode of obtaining solid bitumen and petroleum from a spring near Anderica, on one of the Ionian islands, and of separating them from each other and from foreign substances. This spring is flowing there to-day.

Diodorus Siculus and Josephus noticed the bitumen of the Dead Sea, its use in medicine and in coating ships; its importation into Egypt; and its being there used with aromatic spices for the purpose of embalming bodies, which it preserved from putrefaction.

In their structures, the Romans directed much attention to solidity and permanence, and of course endeavored to select what was considered the most useful and durable materials. That these materials were often good is shown by the state of preservation of many of their works, and by the fact that their cement is scarcely equaled by any of modern time; and yet Vitruvius, a celebrated architect of the age of Augustus, speaks of bitumen as superior to every other kind of cement, and regrets its scarcity.

Notwithstanding the long time that native bitumens have been known, it is only within the present century that they have come to be extensively employed in the arts; and that geologists and chemists have reached definite conclusions concerning their origin, modes of occurrence, properties and relations. The prevalent notion that these substances are of rare and limited occurrence is entirely erroneous, for, as I shall presently show, the bitumens, taken as a class, are very widely and abundantly diffused through the crust of the earth. They are found in every quarter of the globe, and in every geological formation from the Cambrian to the present time. Their occasional association with what appear to be igneous rocks, has led some writers to infer that in their origin they are in some way connected with volcanic action—an explanation which, as Canon Kingsley has remarked, "savors somewhat of a 'bull;' for what a volcano can do to pitch, save to burn it up into coke and gases, it is difficult to see." When, as undoubtedly sometimes happens, the bore of a volcano passes through sedimentary strata holding bitumen or bituminous coal, it is easy to see how the connection of these substances with volcanic products may arise.

But be their associations what they may, it has been definitely settled that in their origin the bitumens, like the coals, are always strictly organic. In every case they are the more or less transformed tissues of plants or animals.

Under the general name of bitumen are included both the liquid forms, petroleum and naphtha, and the solid varieties such as asphalt. Chemically considered, the bitumens are hydrocarbons, the average composition being represented by the general formula C_nH_{2n}. The so-called bituminous coals, which, however, are destitute of true bitumen, are likewise hydrocarbons. These are distinguished from the bitumens by their smaller hydrogen ratio, analysis affording the general formula $C_n H_n$, and by the important facts that unlike many of the bitumens they are not liquid at ordinary temperatures, and unlike all the solid bitumens, are incapable of assuming the liquid state on the application of heat. The coals partake in a large degree of the nature of their chief constituent element, carbon, the most thoroughly solid substance known, distinguishing as we should, solidity from density. In their entire insolubility, again, the coals are strongly contrasted with the bitumens, the latter class being all more or less soluble in liquids like benzole, sulphide of carbon, oil of turpentine, and ether; and the less fluid bitumens, as asphalt, dissolving in the more fluid, naphtha-like, varieties.

Notwithstanding the general distinctness of these two great classes of native hydrocarbons, there is a point where they are not easily separated. Among the bitumens there are different degrees of fusibility and solubility, and a concomitant variation of the hydrogen ratio, presenting a regular gradation as we pass from naphtha with the maximum solubility and fusibility, and the largest proportion of hydrogen, through petroleum, mineral tar, and the various asphalts to idrialite, which, having the composition of bituminous coal, is fusible with difficulty, and only slightly soluble. From idrialite the passage is easy to true bituminous coal, and from this, as is well known, to anthracite. So that, as Dr. T. Sterry Hunt has stated it, "Anthracite or nearly pure carbon, on the one hand, and petroleum and naphtha, or carbon with a maximum of hydrogen, on the other, represent the two extremes of a series of which bituminous coals and asphalts are intermediate terms."

Following is a list of the more important members of this series, with their formulas, which have been calculated for twenty-four equivalents of carbon, to compare with the chief constituent of wood, cellulose:

Cellulose		$C_{24}H_{40}O_{20}$
Naphtha, Petroleum		$C_{24}H_{50}$
Mineral Tar		$C_{24}H_{48}$
Asphalt	varies from	$C_{24}H_{44}O$
	to	$C_{24}H_{38}O$
Idrialite		$C_{24}H_{16}$
Bituminous coal	varies from	$C_{24}H_{30}O_3$
	to	$C_{24}H_{16}O$
Anthracite	varies from	$C_{24}H_{10}O$
	to	$C_{24}H_6O_{.5}$

A little study of these figures will make it clear that all these different hydrocarbons may be produced, theoretically at least, by removing from cellulose, which represents all woody matter, variable proportions of carbonic anhydride (CO_2), marsh gas (CH_4), and water (H_2O); and this is, in many cases, the course that nature pursues. Under ordinary conditions decaying wood is attacked by the oxygen of the air and burned up to carbonic anhydride, water, and ashes, as completely as if thrown into a furnace; but if kept out of contact with the atmosphere, as when lying beneath the water and mud of a marsh, or buried in deposits of sand or clay, the wood is still subject to decomposition, though the decay is of a very different order and much less complete. The oxygen is the most active element of the wood, and the first to leave; but it never goes alone, always taking with it some of the hydrogen in the form of water, or of carbon as carbonic anhydride. Afterwards other portions of the carbon and hydrogen unite and make their escape as the inflammable gaseous substance known as marsh gas. The presence of this gas in most swamps and marshes attests that nature's laboratory for the manufacture of coal and bitumen is still in operation. Both these species of decomposition, whether in the air or out of it, go on much more rapidly in the presence of heat; the first process being exemplified in every stove and furnace, and the second by the charcoal pit; for anthracite, the ultimate product of slow decomposition out of contact with the air, is simply a mineral charcoal.

A further inspection of our formulas will make it evident that to transform cellulose or wood into the average bitumen we must remove all the oxygen, some carbon, and but little hydrogen; while for the conversion of vegetable matter into coal, the oxygen is less completely removed, and the hydrogen suffers much greater loss than the carbon. In the one case the escaping volatile products of the decomposition are mainly carbonic anhydride with some marsh gas; and in the other case the loss has occurred chiefly in the form of water, the carbon remaining largely intact. This is an important difference, and one which would be more obvious if our series included all the varieties of coal. The fact is this series is not a very natural one after all. It represents fairly well the changes resulting in the production of the different bitumens, viz.: a complete abstraction of the oxygen and a gradual diminution of the hydrogen; but the coals are generated by a gradual diminution of both elements, as the following series will show, the formulas being still computed for comparison with cellulose:

Peat and Brown coal		$C_{24}H_{36}O_{18}$
Lignite		$C_{24}H_{24}O_7$
Bituminous coal	varies from	$C_{24}H_{30}O_3$
	to	$C_{24}H_{16}O$
Anthracite	varies from	$C_{24}H_{10}O$
	to	$C_{24}H_6O_{.5}$

We are, then, to regard the coals and bitumens as forming two distinct but parallel series, in each of which there is an evident tendency to the reduction of organic matter to the state of pure carbon. Theoretically, at least, the results, like the starting points, are chemically the same for the two series; but they are reached by different roads. Graphite, which is essentially pure carbon, is the final term of the coal series, and it is not improbable that diamond stands in the same relation to the bitumens, for Liebig has suggested that diamond is most probably formed by crystallization of carbon from a liquid hydrocarbon.

Oxygen and hydrogen exist in cellulose in the right proportions to form water, and the conversion of this substance into coal, as already stated, consists mainly in the union of these two elements. But we may now profitably notice some important observations of Principal Dawson, according to which we should no longer regard the ordinary vegetable fiber or cellulose composing the main body of plants as the principal source of coal, but certain epidermal tissues which differ from cellulose in being much poorer in oxygen. In other words, it is the bark mainly, and not the solid wood from which coal is formed. Dr. Hunt gives the composition of cork, which is a bark, as $C_{24}H_{37}O_7$. These cortical tissues, Dawson says, "are very little liable to decay, and resist, more than most other vegetable matters, aqueous infiltration, properties which have caused them to remain unchanged and resist the penetration of mineral substances more than other vegetable tissues. These qualities are well seen in the bark of our American white birch (*Betula alba*). It is no wonder that materials of this kind should constitute considerable portions of such vegetable accumulations as the beds of coal, and that when present in large proportion they should afford richly bituminous beds. All this agrees with the fact apparent on examination of common coal, that the greater number of its purest layers consist of the flattened bark of the sigillariæ and similar trees, just as any single flattened trunk embedded in shale becomes a layer of pure coal. It also agrees with the fact that other layers of coal, and also the cannels and earthy coals, appear under the microscope to consist of finely comminuted particles, principally of epidermal tissues, not only of the fruits and spore cases of plants, but also of their leaves and stems."

Every one, I think, must have observed, at some time, decaying logs, or better, stumps, of which little or nothing remains but a cylinder of bark, and this is apparently little altered. Dawson has found such hollow stumps in the coal formation, with abundant evidence that they had been the homes of animals, such as insects and reptiles. Such phenomena are the best illustrations of the superior resistance which this class of vegetable tissues offers to atmospheric action, a resistance undoubtedly due to the small proportion of oxygen which they contain; their composition, as Dr. Hunt has pointed out, approaching closer to resins and fats than to wood, and, "like these substances, they repel water, with which they are not easily moistened."

We have now traced to their origin in the vegetable kingdom all of the coals, so far as known, and many of the true bitumens. The notion is rapidly gaining ground among geologists, however, that the bitumens, especially the lighter and more fluid forms, such as petroleum and naphtha, are largely of animal origin. This view, for the development of which we are mainly indebted to Dr. T. Sterry Hunt, is based upon the following general considerations: (1) Animal tissues, the average chemical composition, but not the molecular structure, of which may be represented by the formula $C_{24}H_{36}N_4O_4$, approaches even more nearly than epidermal vegetable tissues to the composition of bitumens. (2) Although, as a rule, eminently unstable compounds, subject, under ordinary circumstances, to rapid and complete decomposition, yet we have good reason to believe that there are vast regions where the conditions are not only favorable for, but must necessitate, that slow and partial decay resulting in the formation of bituminous substances. The regions referred to are the depths of the ocean. Recent researches have shown, contrary to the old idea, that the deep sea holds an abundant fauna. All grades of animal life, from the highest to the lowest, have need of a constant supply of oxygen. Now on the land, vegetation is constantly returning to the air the oxygen consumed by the animals, but in the abysses of the ocean vegetable life is scarce or wanting, and hence it must result that over these greater than continental areas, countless myriads of animals are living habitually on short rations of oxygen, and in water well charged with carbonic anhydride, the product of animal respiration. As a consequence, when these animals die their tissues do not find the oxygen essential for their perfect decomposition, and in the course of time become buried, in a half decayed state, in the ever increasing sediments of the ocean floor. The same thing must happen to animals living in higher bathymetric zones, all the way to the surface, whose bodies sink to the bottom after death; they yield a little ammonia and carbonic anhydride, and then pass into the comparatively stable condition of a liquid or solid bitumen. During the lapse of ages these sediments, rich in organic matter, will be consolidated into limestones and slates, and at a later period may be elevated to form new land; a process which has been many times repeated in the past. (3) For, as geologists well know, rocks corresponding to those just described, are of very frequent and extensive occurrence among the formations now exposed to their observation.

Petroleum is usually associated with salt, the same well often affording both oil and a strong brine; a fact very suggestive of the marine origin of the petroleum. While the disagreeable smell of some oleiferous limestones is probably due, as remarked by Newberry, to the animal origin of the oil.

The capability which the so-called bituminous coals possess of yielding, by a process known to chemists as destructive distillation, various liquid and gaseous hydrocarbons, some of which resemble petroleum, a property common to most substances of organic origin, has not only led to their being erroneously regarded as bituminiferous, but many geologists have inferred that we have here a clew to the origin of the vast reservoirs of petroleum known to exist in this and other countries, and which have of late years been tapped with such astonishing results. Anthracite is undoubtedly a species of natural coke, produced when ordinary bituminous coal loses its volatile ingredients; its general mode of occurrence and geological relations prove this. But is nature's mode of making coke strictly analogous to what goes on in the retorts of the gas works? Probably not. We have every reason to believe that the natural process is a very gradual one, and that the volatile products are all gaseous. In every bituminous coal mine in the world the two permanent gases, carbonic anhydride and marsh gas—the deadly choke-damp and fire-damp of the miners, are constantly escaping from the coal, but unaccompanied by any oily, petroleum-like liquid. This action, sufficiently long continued, must result in the production of anthracite, and that it has so resulted is evidenced by the fact that the rocks lying above the great deposits of anthracite are quite free from the liquid bitumens we should otherwise expect to find there. The fact is, that in Pennsylvania the anthracite is in one end of the State, and the petroleum in the other; and, moreover, the petroleum is obtained from a formation below the carboniferous, to which the coal belongs. Its origin is sometimes referred to the carbonaceous shales or pyroschists of the underlying Hamilton beds; but these, like the coals, are found, on examination, not to contain any bitumen, and like the bituminous coals, they still retain perfectly the power of yielding bitumens when sufficiently heated. Beyond the limits of Pennsylvania the general facts are the same, and nowhere is there any evidence proving a connection of the petroleum with the coals or pyroschists. Petroleum is generally obtained from wells sunk in sandstone or slate. In some cases it is probably indigenous in these, but usually it has been forced up by hydrostatic pressure or sponge-like absorption from oleiferous limestones. There are several extensive formations of these limestones in Eastern North America, and geologists are only beginning to appreciate their abundance and richness. The oil is found filling the pores and cavities of fossil shells and corals, and saturating the entire substance of the limestone, the evidence being plain that it is indigenous in this position, and has not been introduced into the limestone subsequent to the formation of the latter. Dr. Hunt has made a quantitative determination of the petroleum in a limestone of Niagara age occurring near Chicago, with the following almost incredible result: Although the formation has a thickness of only thirty-five feet, yet in each square mile it must contain not less than "seven and three quarter millions of barrels of petroleum." He says further, "The total produce of the great Pennsylvania oil region for the ten years from 1860 to 1870 is estimated at twenty-eight millions of barrels of petroleum, or less than would be contained in four square miles of the oil-bearing limestone formation of Chicago."

As a rule limestone is too massive and close-grained to permit the oil to flow freely through it to supply wells sunk in this rock; but overlying sandstones gradually soak up the oil, and its accumulation along the crests of anticlinal arches in the latter rock is due to the presence of water in the strata, which, being the heavier liquid, forces the oil to the top. The richest wells are those which tap large bodies of oil contained in the great fissures and cavities which, as geologists well know, usually accompany an anticlinal fold of the strata. Very often these subterranean chambers are filled partly with oil and partly with gas, and the latter serves a useful purpose in forcing the former to the surface. This gas is derived from the oil itself, and if the situation of the fissure or the texture of the rock is such that the gas can escape, its formation will continue until, in some cases at least, the petroleum is reduced to a thick viscid or even solid condition. It is by a similar but more rapid fractional distillation that the petroleum is refined for illuminating purposes, the solid residue being chiefly the substance paraffine. The fissures filled with solidified or inspissated petroleum are not wholly theoretical, but several have been discovered, which, through some accident of erosion or faulting of the strata, are now exposed on the surface. The most noted of these is in New Brunswick, the material occupying the fissure being the famous and valuable mineral, albertite. This is a jet-black lustrous substance intermediate in physical characters between bituminous coal and asphaltum, though chemically it is much nearer the latter than the former, affording the formula $C_{24}H_{28}O_{1.5}$. This deposit bears no resemblance to a true coal bed, but fills a large irregular crevice cutting across the strata. The inclosing shales are rich in the remains of fish, and so bituminous as to be visibly oily, and to "sustain a fire without the aid of other fuel." The grahamite of West Virginia is a substance closely resembling albertite, and occurring in a similar fissure or crevice. The same phenomena, on a smaller scale, are many times repeated in Canada, in the vicinity of Quebec and elsewhere.

* *American Naturalist.*

Whenever petroleum is exposed to the air for any length of time, as when it slowly exudes from the rocks, forming petroleum springs, it is likely, in a manner similar to that just described, to lose its more volatile ingredients and become semi-solid like mineral tar, or solid like asphalt. And so it happens that many of the smaller deposits of asphaltum in this and other countries are simply dried up petroleum, and are of animal origin. The great deposits of the globe, however, those which constitute the principal source of the asphaltum employed in the arts, do not appear to have been formed in this way; but have, in most cases at least, been derived directly after the manner of coal, as already explained, from decaying vegetation.

Extensive deposits of asphaltum, such as that for which the island of Trinidad is celebrated, are commonly regarded as something exceptional, something out of the natural order, a freak of nature. This notion is without foundation in facts, for asphaltic substances are not only widely disseminated, as already stated, but in not a few localities, which form a zone girdling the earth, they are accumulated in such vast abundance as to insure an unfailing supply for man's purposes for all time to come.

A list of the localities where asphaltum is especially abundant may further enforce this view, these are: Cuba, several of the Windward Islands, especially Trinidad and Barbadoes, the Caribbean shore of South America, particularly the province of Maracaybo, Caxitambo and Berengela in Peru, where are lakes of asphalt similar to that on Trinidad; Mexico, Texas, and California in North America; Persia and Arabia, Palestine on the shores of the Dead Sea; and on Mount Lebanon, Ionian Islands, France, Switzerland, and Portugal. It is a curious fact that the asphalts are confined almost wholly to tropical and sub-tropical regions. There appears to be in low latitudes some general climatic or other condition which has in many cases determined the conversion of vegetable matter into bitumen instead of coal.

The largest deposit in Europe is probably that in the Val-de-Travers, Neufchatel, Switzerland, which has been worked for more than one hundred and fifty years. This occurs in rocks of cretaceous age; but as a rule the great masses of asphalt are found in connection with tertiary strata. This is the geological position in Trinidad Barbadoes, Peru, and other points in South America and in California. Trinidad is composed chiefly of tertiary and secondary beds, the former predominating; but toward the north the island, otherwise quite low, is bordered by a bold range of mountains, a detached link of the great littoral Cordillera of Venezuela. These are composed of ancient crystalline strata, and stand like a wall between the tertiary plain on the south, and the Caribbean sea, and the long chain of volcanic islands on the north. There is scarcely a trace of true volcanic action observable in Trinidad, the hot mud springs—the so-called mud volcanoes—hardly coming in that category. They must be classed as hydro-thermal, but not as igneous phenomena. I have also seen little or no evidence of volcanic action during the past epochs in the history of the island; and the frequent severe earthquake shocks of the regions on the west and north are very rarely felt with destructive force in this favored isle.

BRILLIANT GAS LIGHTS.

THE display of the electric light during the past nine months seems, says *The Engineer*, simultaneously to have convinced the London gas companies that they must produce gas a little better and a little cheaper, and the public that there is some reason in the often made complaint that, considering the means at our disposal, our streets are generally very badly lighted, and that a little more must be paid for much better illumination. Every one has read something respecting the exhibitions which have been recently made of improved means of burning gas, and we now illustrate the lamps and burners erected by Mr. W. Sugg, of Vincent-street Works, Westminster, in Waterloo-place and Regent-street.

From our illustration it will be seen that the lamp is of a form resembling those commonly used outside large buildings with oil many years ago. It is, however, of very large size, and is fitted with a very effective ventilating chimney. Inside the cupola seen on the top of the lamp are several concentric rings of sheet iron or tin, perforated with holes not opposite. Below this also there are six small panels of perforated plate, inside which are baffle plates by which the incoming air is deflected and kept away from the strong rising hot current at the center. The ventilation is most complete, and the lamp consequently remains sufficiently cool, though so large a burner is used. The lower panes of glass are clear, but the upper panes are of a white glass, of very small dioptric capacity, and which reflects the greater part of the whole light downward. The result is that the space around each lamp-post is thoroughly lighted, and there are no shadows from the lamp framing, the post itself being lighted up. The burner as shown by Fig. 2 is one-half in elevation and one-half in section, showing the centric annular steatite burner rings, X X, and the regulator disk, D, and its valve, V. This disk is provided with a number of grooves at its periphery, and is carefully fitted in the cylinder. A little non-corrosive oil which will not easily freeze keeps the regulator disk or diaphragm perfectly tight, and no matter what the variation in the gas pressure, the quantity passed to the burner remains the same down to the minimum at which it is set, the greater pressure raising the disk and with it the valve, V, against its seat. These regulators form a most important point in the success of these lights and the various Argand burners introduced by Mr. Sugg for domestic and other purposes. There is in reality little use in a regulator on the gas main. The regulator is required under each burner. By this means the economy and regularity of light, otherwise unattainable, are secured. In the smaller burners, which give a light equal to 23 standard sperm candles with a consumption of 5 cubic feet per hour of 16-candle gas, and which were at first fitted to the lamps in Waterloo-place, there is but one ring, the burner being similar to those used in houses; but the burner now employed has two rings, as shown, and in the center is a small burner constantly alight, called a flash light. This is never turned out, burns a very small quantity of gas—1 cubic foot in four hours—and avoids the necessity of opening the lamp to light it. The little flash light is also regulated by a small disk regulator, separate from the burner. The burners now fixed, and which secure an effect in illumination which the electric light on the Embankment has yet to approach, are, with the exception already named, of 80 standard candle power, but will give a light of from 85 to 90 candles with the 20 cubic feet of gas they are designed to burn. There are two burners of 100 standard candles power, and which will give a light of 115 candles with the 25 cubic feet of gas they are regulated to consume per hour. Between the United Service and Athenæum Clubs is a burner of 200-candle power designed to burn 50 cubic feet per hour, but generally that quantity of light is given with from 45 to 48 cubic feet. The 100-candle burners have three flame rings, and the 200-candle have four flame rings, but in every other respect are similar to the burner illustrated by Fig. 2. The lamp for the 200-candle burner is twelve sided instead of six-sided, as illustrated for the 80 and 100-candle burners. All the lamps are perfectly steady, wind cannot affect their steadiness, as the air can only enter in the proper channels, there being no opening at the bottom. The standard burner of the gas referees gives a light equal to 3·20 standard candles per cubic foot of 16-candle gas. The "London Argand," which, as we have mentioned, was temporarily fixed at Waterloo-place, gives a light equal to 3·50 candles per foot, while the two ring argand gives a light equal to 3·8 standard candles per cubic foot of 16-candle gas, which is, according to the tests of the gas referees, the highest duty yet obtained.

The efficient and hitherto unequaled lighting of Waterloo-place is being carried out by the Gas Light Company at its own expense. The lighting hitherto of this piece of roadway, which is about 500 yards in length, and of considerable width at the lower end, has been effected by means of forty-two lamps, burning 2½ cubic feet of gas per hour, and the light from each was equal to nine candles. Thirty-six of these lamps are on the footways, four on the street refuges, one between the Athenæum and the United Service Club houses, and one opposite the County Fire Office. There were, therefore, 105 cubic feet of gas used per hour in these lamps, which, being cannel gas, costs 4s. 4d. per 1,000 cubic feet, and amounts to 5½d. per hour. There are also several lamps attached to the Guards' Memorial, but they have been excluded from the experiment. Taking the actual consumption of gas, the cost of the lighting as shown by the experiment now in progress is estimated as follows:—Thirty-six footway lamps, at 19 cubic feet each, burn a total of 684 ft. per hour; the four refuge lamps, at 23 ft. each, 92 ft. per hour; and the two large lamps, at 45 ft. each, 90 ft. per hour. This gives a total of 866 ft. of gas per hour, affording an illuminating power of 3,680 candles, and costing, at 4s. 4d. per 1,000 cubic feet, 3s. 6¾d. per hour. This is a large increase upon 105 cubic feet per hour consumed by the 42 old lamps, and costing only 5½d. per hour; but the improvement in the illumination, which is of the highest character, is greatly in excess of this augmented cost, as shown by the proportions of gas consumed and light given. This cost is, of course, considerable, but if we must have bright light, we must pay for it. It may be remarked however, that the light given by the single ring London-Argand was a vast improvement upon the old lights, and the cost a comparatively small increase on the old rate. Clear it is, however, that gas may still drive the electric light out of the field, especially when it is hidden under a bushel as it is on the Embankment. Until a more economical burner is secured, the electric light will cost more than gas for illumination equally effective as that in Waterloo-place.

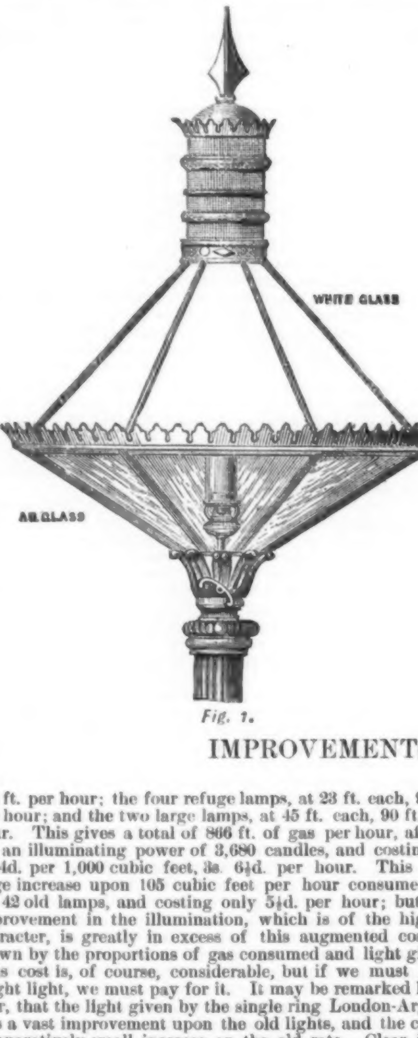


Fig. 1.

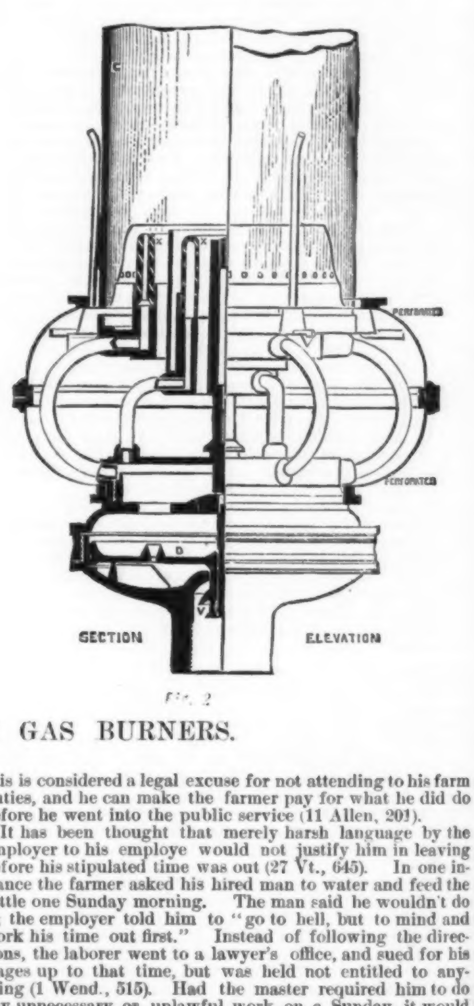


Fig. 2

IMPROVEMENTS IN GAS BURNERS.

[Continued from SUPPLEMENT No. 166.]

FARM LAW.

HIRING HELP.

AFTER taking possession of the farm, one of the first, and often one of the most trying duties of the farmer, is to hire his help. Every employer of labor knows full well that, if a man is hired without any special bargain as to the price, he is entitled to the current rate of wages for such labor, and no more; but every laborer may not be aware that, if he engages to work for a year, but leaves without good cause at the end of eleven months, he is not legally entitled to any compensation for what he has done, but forfeits the whole; and this is so, whether he has agreed to stay for the entire year at one round sum or for twenty dollars a month (12 Met., 286); although, if the farmer had paid for each month's work, as it came due, he could not probably recover it back, even if the laborer afterwards wrongfully left him before his time was out (17 Vt., 355; 1 Cush., 279). And, if he has given a note for the amount already earned, he must pay the note, notwithstanding the subsequent failure of the other party to work out his full time (13 Johns., 53). But if nothing has been paid, and no note given, the laborer would not only forfeit his wages, but would also be liable to pay the employer for any damage done him by leaving him without help at a critical time in the year; therefore, if he has agreed to work a year for twenty dollars a month, and quits just before haying because he can get forty dollars at mowing for some one else, and the farmer has to pay that price to get another man to supply his place, he can recover of the laborer the extra twenty dollars a month for the balance of the unexpired engagement, as damages caused him by such breaking of the contract; and the laborer could not set off against the claim of the employer the value of the work he had really done, and not been paid for (4 Wend., 605). And this is so, whatever specific thing you hire a man to do. If he engages to build you a barn for five hundred dollars, to lay up a hundred feet of stone wall for a dollar a foot, or dig a well twenty feet deep for twenty-five dollars, and voluntarily quits without good excuse when the job is half done, you are not obliged to pay a single cent for what he did do (2 Mass., 147; 11 Gray, 396); although, if he had substantially completed it in good faith, he would not lose all his labor because, in some minute particulars, he had not finished it exactly according to the precise terms of the contract (7 Pick., 181; 9 Allen, 355).

On the other hand, if the laborer has good cause for leaving, he may do so, and compel the employer to pay for the time he actually did work. And among the well-known excuses for leaving before the original bargain contemplated, are sickness of the hired man, or his physical inability to labor (11 Met., 440), or the prevalence of some dangerous epidemic in the family or in the vicinity, which might render it hazardous for the man to remain; such as cholera, small-pox, and the like (43 Me., 463). Any improper treatment by the employer, as scarcity of suitable food, is also deemed sufficient excuse for seeking other quarters.

And even though the laborer so misbehaves himself that he is arrested and imprisoned for some crime, and so is busy picking oakum for the county in the house of correction, this is considered a legal excuse for not attending to his farm duties, and he can make the farmer pay for what he did do before he went into the public service (11 Allen, 201).

It has been thought that merely harsh language by the employer to his employe would not justify him in leaving before his stipulated time was out (27 Vt., 645). In one instance the farmer asked his hired man to water and feed the cattle one Sunday morning. The man said he wouldn't do it; the employer told him to "go to hell, but to mind and work his time out first." Instead of following the directions, the laborer went to a lawyer's office, and sued for his wages up to that time, but was held not entitled to anything (1 Wend., 515). Had the master required him to do any unnecessary or unlawful work on a Sunday, it would probably be a good excuse for his leaving (8 Conn., 14; 1 Browne, 29); but necessary farm-work, such as care of live animals, may undoubtedly be required on Sunday (16 Jur., 549; 6 Dunl., 1256). But inasmuch as it is always a question for the jury to decide whether the man had good cause for leaving (14 Gray, 454), their sympathies are very apt to be with the employed, and they usually think the laborer is worthy of his hire. The cheaper way, generally, in such cases is, if the amount is not large, to pay the man, let him go, and never hire him again.

What we have before stated about a forfeiture of wages is founded upon the doctrine that the laborer has made an entire contract, and that he must faithfully fulfill it, or be is entitled to no pay; therefore, if for any reason this entire contract is not valid and binding on the laborer, he may disregard it entirely, and quit when he likes, and still recover for all the time he did work. For this reason, if the bargain is to work for more than one year, or even for just a year, but to commence at some future day, as a week after making the bargain, and the contract is not written down and signed (which nobody ever thinks of doing), it is not binding on the laborer, and he can break it from a mere whim, and still make the farmer pay (5 Gray, 41). In like manner, if the laborer is under twenty-one, he is not bound by his bargain, but may desert when he pleases (2 Pick., 332; 19 Pick., 572), and recover "back pay." And this is so, although the young man appears to be of age, or is married and has a family (37 Vt., 647; 41 N. H., 346), or even though he falsely stated he was over age, and able and willing to make as good a bargain as if half a century old (11 Cush., 40; 10 N. H., 184).

But even if you have a nominal remedy against a laborer who has left you unjustifiably in the midst of his contract, this so often proves practically worthless, that the law also gives you a right of redress against the person who has enticed him away with the offer of better wages, or otherwise. The law does not allow one man thus to interfere with another man's business without being liable to pay for all the inconvenience and loss he may thereby cause to the person whose men are thus induced to break their contract with their former employer (107 Mass., 555; 56 N. H., 456).

It is for this reason that combinations among workmen for a strike, and to induce fellow-workmen, by intimidation or otherwise, to forsake their employers, are clearly illegal, and render the parties involved liable both civilly and criminally. Such associations are more common among operatives than farm laborers; but I suppose the same rules apply to both.

LIABILITY FOR HIS MEN.

The liability of a farmer who employs many hands may prove extremely onerous at times. As a general rule, he is liable for all the injury they do while actually employed in his business: therefore if you send a boy to burn old brush, and the lad leaves his work to look after his partridge-snares or rabbit boxes in the wood, and the fire runs into the next field, and consumes the crops or fence of your neighbor, you must pay the bill, although you told him to watch it carefully, and never leave it a minute (5 Gilm., 500; 7 Cush., 385). If you send a load of farm produce into town, and the driver falls into a dose and runs into another team, you must pay for the broken spokes. If your man, in going to and from the hay-field, carelessly swings his scythe, and cuts an ugly gash in the leg of a passer-by, you had better pay the doctor's bill, and be glad to get off thus easy. If, in cutting your wood, a man accidently cuts over the line, on your neighbor's lot, you are responsible, although you told him where the line was (23 Mich., 298). And although your man shows a touch of maliciousness in his act done in the prosecution of your business, and intentionally runs into another team which somewhat obstructs his way while driving your load, you may not screen yourself behind his unnecessary and willful violation of your orders (12 Allen, 49; 114 Mass., 518; 109 Mass., 154). Of course, in all these cases, you could compel the servant to repay you all the expenses he had thus caused you by his misconduct (63 Me., 177; 43 Conn., 244). On the other hand, to make you responsible for his carelessness, he must have been at the very time on your business. If he borrows your horse and wagon, and goes off on pleasure, or business of his own, and runs over somebody, you are not responsible, merely because it was your horse and wagon (26 Penn., St. 482); much less would the master be liable if the servant took his team without his knowledge on pleasure or business of his own (4 Daly, 338).

How it would be if the fellow was on his own business and yours too, is a nice question, which might puzzle even a "Philadelphia lawyer." In one instance a farmer lent his man his team to go to town for a holiday, and asked him to stop at the butcher's on his way home, and bring along a piece of meat for next day's dinner. While fulfilling this order, the man took a little "fire-water," and soon after ran over an old woman in the public highway; but the master was considered not responsible. This was, however, in the courts of the Emerald Isle (9 Irish L. R., 557).

One more distinction on this subject it may be well for you to know; and that is, that, although an employer is responsible for any careless injury his men may do to third persons, he is not responsible for such an injury to other fellow-workmen. If his man, therefore, by the very same act of negligence, injures a co-laborer and also a bystander, the latter would have redress against the master, and the other not; for, by a species of rather artificial reasoning, I think, a man when hiring out, is supposed in law to have anticipated any direct injury from the carelessness of his co-laborers, and taken the risk on himself (but not to his wife, 112 Mass., 234), whatever his rate of wages. But, on the other hand, he is not presumed to have contemplated any negligence on the part of his employer; and therefore he has a remedy against the latter for his own personal carelessness, or in providing dangerous or insufficient machinery or apparatus, or even in hiring notoriously incompetent or habitually careless men. In one instance an employer was compelled to pay two hundred dollars to his hired man, who fell into a barrel of hot water, set in the ground and carelessly left uncovered, but which the man did not know of (111 Mass., 322). And this last rule would probably render the employer liable for any injury to his servants from dangerous or vicious animals intrusted to them to take care of; at least, if the owner knew of their character, and the man did not. But this whole subject is surrounded with subtle distinctions; and my best advice to you is, that, if you ever have such a case, you do not rely upon this lecture, nor upon any of those books called "Every Man his own Lawyer," but go and get the best legal counsel you can find.

ABOUT FIRES.

If a careless hunter fires your woods, and, much to his consternation, the flames spread to your fields, and run along the fences to your barn, he is responsible for the whole loss, although he did his best to stay its progress. A man who wrongfully sets in operation a dangerous instrument, must take all the consequences directly caused thereby (21 Pick., 378; 43 Cal., 437; 2 Harr., 443); and this would be so, whether the fire ran along the ground continually, or whether the sparks were blown through the air a considerable distance, and then set fire to some person's property (107 Mass., 494).

But as any farmer has a legal right to burn the brush, old stumps, etc., on his own land, if he does so at proper times and in a proper manner, he is not responsible, if, by a sudden rise of wind or other cause, without negligence on his part, the fire is accidentally communicated to a neighbor's premises, and causes him serious injury. The gist of his liability in such cases is some carelessness either in the time of setting the fire, or the manner of doing so, or in watching it afterward; and the man who suffers is bound to make it clear that the other was to blame (54 Me., 259; 22 Barb., 619; 44 Barb., 424; 18 Me., 32; 11 Met., 460). But even your negligence will not always render you liable for the spread of a fire, unless it was originally kindled by you intentionally. Therefore, if your barn takes fire through your carelessness with the lantern, or that of your man with his pipe, and thereby your neighbor's property is also consumed, you are not bound to pay for it; the law seems to consider that you have suffered enough for your conduct in the loss of your own property (1 Bl., Com. 431; 37 Barb., 15; 35 N. Y., 210; 62 Penn., St. 353).

Still less would you be responsible if the fire originated from causes beyond your control. If your barn is struck by lightning, or your hay-stack ignites by spontaneous combustion, without any fault on your part, and the flames spread to the adjoining owner's property, it would be hard indeed if you had not only to lose your own, but to pay for his also (8 Johns., 422; 11 Q. B., 347). And I suppose, even if you were careless in not promptly and energetically putting it out when you could have done so, and it spreads beyond your control, this would not render you liable, as perhaps it might have done had you purposely set fire to your brush heap or stubble.

As to railroad fires the law is somewhat different from that relating to individuals. Formerly, and antecedently to any statutes, railroad companies were not liable for fires caused by their locomotives, without proof of some negligence, either in the construction or mode of running the engine by which the fire was caused, or otherwise (5 H. & N., 674; 18 Barb., 80; 30 Iowa, 420; 15 Conn., 124; 37 Me., 93); but as the liability to such fires was so great, and the amount of damage so caused was very extensive, it became necessary to enlarge their liability; and now in this State, by Gen. Stat., chap. 63, § 101, railroad corporations are liable for all damages to the buildings or personal property of land-owners along their route, arising from fire communicated by their locomotives, and without any proof of negligence or carelessness, either in the company or any of its employes.

And this statute has a very liberal construction, extending not only to buildings immediately adjoining the railroad, and which are fired directly by sparks from the locomotives, but also to buildings at a long distance from the road, and which are set on fire by sparks flying through the air from some building nearer by, which had first taken fire from the engines (13 Met., 99; 98 Mass., 414; 103 Mass., 586).

As a protection to themselves, however, railroad companies are authorized to get the property along the route insured for their benefit; so that, if obliged to pay, they may remunerate themselves, and thus the burden is more equally divided. Different States may have different statutes upon this subject.

WAYS OVER THE FARM.

Others may acquire a right of way over your farm in either one of three modes: 1st. By purchase or grant from you; 2d. By long-continued use or prescription; 3d. By actual necessity. As to the first method, to gain a permanent right by purchase or grant, it must have been by a regular and complete deed, executed in the same way as a deed of the land itself. If the bargain was only oral, or if it was even in some simple written paper, but not in a formal deed under seal, it would, even though fully paid for, be in law revocable—a mere license, as it is called—and might be terminated, at the mere wish of the land owner, by a notice to the other party to use it no longer. Being a kind of interest in land, the strict law requires it to be conveyed by a deed (2 Gray, 302; 2 Allen, 578).

2d. The second mode, by prescription, requires length of time—twenty years at least; and the way must have been used continuously, peaceably, and under a claim of right to do so, and not by your permission or consent. If it was only very rarely used, if it was not peaceably used, but against your protest, or if used by your tacit consent, the use would not ripen into a legal right, however long continued (8 Gray, 441; 11 Gray, 148). And, if used under all those conditions, it must have been in some regular and uniform place. No man can gain a right by such means to wander over your farm just where he has a mind to or where his convenience suits him; that would be an intolerable burden to the farmer (5 Pick., 485).

To gain this right by twenty years' use, it is not necessary that any one owner should have traveled it twenty years. If successive owners have unitedly used it for that period, it would be sufficient, so far as length of time in concerned (2 Allen, 277). And if this prescriptive right of way was gained only by using it for some particular purpose, as for carting wood from a wood-lot beyond, that would not authorize the person to continue to use it for all purposes, after the wood had been all cut off, and it had been covered over with buildings (11 Gray, 150; 15 Gray, 387).

3d. The third mode, by necessity, arises when you sell a man a back lot, with no means for him to get to any highway except over your remaining land. The law gives him a right to cross your land to and fro; otherwise his land would be useless. At present he can't reach it by balloon to any practicable purpose, and therefore he must cross your land. So, if you sell a man all your front land, retaining the back part, and have no way out except over the part sold, you retain a right to cross the lot sold, though your deed in such case says nothing about it; and this is so, even if in your deed you warrant the land to be free and clear from all incumbrances (4 Gray, 297). It is a familiar maxim that "necessity knows no law."

But this right of way by necessity continues only so long as the necessity itself continues; and if a highway is afterward laid out touching the back land on the other side, or if the owner afterward buys a lot adjoining it and between it and a highway, he can no longer cross over your land as before, but must go out the other way (14 Gray, 126). And, so long as he does have such a right, he must go in such place as you designate, if it be a reasonable place. If you mark out a road or a way along the fence, or on the poorer ground, he should confine himself to that (2 Pick., 478). And, if the way becomes miry or out of repair, he must keep it in good condition if he wants to use it. Your duty is done when you allow him to cross: you are not obliged to smooth his pathway for him, and rake out the sticks and stones (12 Mass., 69). But if you actually obstruct his usual road, or if it becomes suddenly impassable by natural causes, he would have a right to deviate to one side until he has opportunity to remove the obstructions (2 Allen, 546).

All such rights of way are apt to be nuisances to the farmer, and not unfrequently lead to litigation.

It is important to know that, in whatever mode a right of way is acquired over your land, you have ordinarily a right, in the absence of any stipulation to the contrary, to erect suitable gates or bars at the entrances thereto from the highway; and if the other party leave them open, and cattle get in, or yours get out, he is liable to you for the damage which ensues (9 B. Monr., 21; 22 Iowa, 161; 44 N. H., 539; 45 Md., 357).

WARRANT OF SEEDS.

Time will not allow me to speak of the general laws of purchase and sale, or of deceit and warranty, about which so much may be said; but there are two phases of it of special interest to the farmer. One is the disappointment resulting from the purchase of impure or spurious garden seeds. It is now well settled that if a dealer in seeds sells an article marked and put up under a certain name, and it is so billed to the purchaser, this amounts to an absolute warranty or guaranty that the seeds are what they were bought and sold for; and, if they turn out not to be, the farmer has a remedy against the seller for the money he paid for the seed. And this is so, although the seedsman was honest in the sale, and bought them for exactly what he sold them for; and he would have a remedy back on the person who sold to him (18 Q. B., 560). But merely to recover back the money paid for the seed would fall far short of the loss to the buyer. His time, labor, fertilizers, profits on his crop are all gone; and the question has been much agitated whether the seedsman is liable for all this loss. And it is now generally understood that when he either expressly warrants the seed to be of a particular kind or variety, or when he so sells it without any reservation or limitation, and thus creates an implied warranty, he is liable for all the damages directly flowing from the farmer's use of such seed.

In one instance a market gardener bought of a seedsman "early strap-leafed, red-top turnip seed," but which proved to be "Russia late," not salable in market, and only fit for "cattle," and he was allowed to recover of the seller the difference between the value of the crop which was raised and a crop of early turnips on the same soil, even though the seedsman honestly thought the seed was as represented (7 Vroom, 262; 9 Id., 496; 34 N. Y., 634). And in case the farmer is so imposed upon, and the seed proves entirely worthless, and his crop of no value, he can make the seedsman pay not only the cost of the seed, but also for all the labor incurred, and the fair profit he would have had from the crop, had the seed been what it was represented to be (69 N. Y., 62). To avoid this serious liability, seedsmen at the present day very often print upon their seed-packages that they do not warrant any seed they sell, which may perhaps relieve them from their responsibility, unless they knew the seed was not true to name.

CULTIVATION OF BEANS.

THE following are the experiences of two contributors to the *Country Gentleman:*

In a recent number of your paper I notice two inquiries on the cultivation of beans as a field crop. This has been an important crop in this locality for many years past, and its cultivation is very well understood, as well as the management in preparing the crop for market. When seasons are unfavorable for ripening and securing, there will be more or less damaged beans in almost every field, and it then becomes an important part of the business to put them in condition for market. This matter is now shifted from the farmer to the dealer, and he finds it the best policy to send none to the eastern market till every defective or stained bean is taken out, which can only be done by hand-picking. Hence the handling and preparing them for market becomes as important a branch of the business as that of growing the crop. Bean growing requires strict care to make it successful; more so than grain growing, for much depends on quality to make them marketable, more so than that of grain. A slack farmer, or one who has not a suitable soil, will hardly make bean raising a profitable business.

The best bean soil is a mellow clay or sandy loam, and it should be of uniform quality, so that the crop will ripen so uniformly that there will be no green or overripe spots at harvesting, either of which will be liable to stain and injure the quality. The preparation of land is the same as that for corn, fitted in the nicest manner, and free from weeds or grass that might grow up and choke the crop. Weedy ground requires too much hand-hoeing for profit, for it must be kept clean or it will not return a fair yield. Weeds are more damaging to this crop than to corn or potatoes, and it requires more hand labor to extirpate them. The proper time for planting is from ten days to two weeks after corn planting. The quantity of seed necessary for marrow beans is $1\frac{1}{8}$ bushels per acre; for mediums, $\frac{3}{4}$ of a bushel, and for pea beans, $\frac{1}{2}$ bushel per acre. Kidney and other large beans require more, in proportion to size. We plant in rows about 28 or 30 inches apart, using a planter drawn by one horse, which plants two rows at a time. It is well to pass a light roller over the field before the planter, so that the seed will all be covered at a uniform depth. As soon as the plants are fairly up and the first leaves formed, the cultivator should be run between the rows; but care must be taken that the plants are not covered. A common one-horse corn cultivator, with teeth that only cut weeds, is best, as beans require no hilling. This should be repeated three or four times, or at intervals of a few days up to the time the vines begin to spread, and if weeds grow the hoe must be used. Otherwise the cultivator will do all the work needed up to the time of harvest.

As soon as the pods are turned yellow, and before they are dry, the crop is ready to harvest. This is done by hand, pulling and setting them up tops downward in small piles, where they remain several days till they are thoroughly dry, before housing. Recently a harvesting machine has been constructed, which is drawn by two horses, traveling between the rows. The machine has two long shares on standards attached to a frame supported on wheels. The shares run so as to cut the bean root an inch or two below the surface of the ground, cutting two rows at a time and bringing them into winrows. The beans are allowed to remain here till partly cured, when they are raked or pitched into piles, ready for drawing in when fully cured. In this way some ten acres are harvested in a day, saving much back-aching work. This machine has been used on my farm the past four years, harvesting forty to fifty acres annually. Thrashing machines in use thrash and clean at about the same expense as grain thrashing. A fair crop should yield about twenty bushels per acre, and crops of thirty bushels and upwards per acre are not uncommon. Your correspondent wishes to know if machines are used in bean raising, and where they are manufactured. The machines mentioned are in common use in this section. The thrashing machines are made in Rochester; the planters and harvesters are manufactured in Brockport; price of planter, \$25; harvester, \$50.—F. P. ROOT, *Monroe County, N. Y.*

The Western New York farmer prepares sod ground by applying a coat of manure, drawn in the winter months, and spread as it is drawn; plows the land, not very deep, as early as he can in the spring, when it is not too wet, and then drags, cultivates and rolls it. He fits the ground just as if he were intending to plant the next day. About the fifth or tenth of June, the weeds will all be germinated, and he uses a two-horse cultivator, with sharp, flat teeth, following with a sharp tooth or spring-toothed harrow, or one of the pulverizing harrows. He then plants it with a bean planter that plants two rows at a time, eight inches apart in the row, and four or five beans in each hill. This planter is manufactured at Carlton, N. Y.; it is double jointed, and plants on uneven land and over ditches without any trouble. Its cost is \$45 with fertilizer attachment, or \$35 without the attachment. For fertilizer, we use hen manure and

plaster, half and half, and plant ten or twelve acres per line.

When the beans come up we cultivate three or four times with a one-horse cultivator close to the rows, after blossoming. We plant the variety called the Early Manly, which gets ripe in about eighty days from time of planting. For harvesting we use a machine manufactured at Holly, N. Y. It cuts and shakes out two rows at a time; is drawn by two horses, and does the work perfectly. Three men to fork them into bunches and one to drive the team will take care of ten to fourteen acres per day, and do not care how stony or sandy the soil is if the stones are not fast. We turn them often and draw in when dry. A thrashing machine made in Rochester has two cylinders; the first one runs slow, the other faster. They cost about $300, and any horse power will run them. They will thrash about 600 bushels per day. These machines are as common here as grain thrashers. We also have a machine for grading them, which takes out all small and split beans, putting them into separate barrels. They will grade 100 barrels per day. They are manufactured at Brockport and cost $70. Farmers here raise from ten to one hundred and fifty acres each, according to size of farms.—Wm. Wood & Son, *Orleans County, N. Y.*

BONE COMPOST.

The following is said to be the statement of a farmer who has used a mixture of bone and soil for fifteen or twenty years, and was published in the *Practical Farmer and Scientific Gardener* in October, 1863.

"Take one ton of ground bone (the finer the better), one-half an ox-cart load (one-fourth of a cord) of good friable soil which will not break or cake by drying, and which is free from sods and stones, no matter how wet it may be when used. Place a layer of the soil and a layer of the bone of about equal thickness upon each other (soil at the bottom) on a floor under cover, leaving a bushel or two of the soil to cover the heap. The heap may be three or four feet wide and about twice as long. In forty-eight hours, it will be too hot to hold your hand in. Let it remain undisturbed until the heap begins to cool, which will be in a week to ten days. Then shovel over the heap, thoroughly mixing the soil and bone. In a day or two it will heat again. Let it remain until it cools, then throw it over in the same manner again. Throw over each ten days until all the moisture in the heap is exhausted, and it does not ferment any more. It is then fit for use."

He has tried many tons prepared in this manner, and side by side with the superphosphates of different manufacturers, and *always* saw the best and most permanent effects from the same amount of bone prepared in this manner. He also tried a ton of bone mixed with ashes, another ton with sand, and a ton with plaster, but found that mixed with soil the best.

THE SILKWORM.*

A Brief Manual of Instructions for the Production of Silk. Prepared by Prof. Chas. V. Riley.

NATURE OF THE SILKWORM.

The silkworm proper, or that which supplies the ordinary silk of commerce, is the larva of a small moth known to scientific men as *Sericaria mori*. It is often popularly characterized as the mulberry silkworm. Its place among insects is with the *Lepidoptera*, or scaly-winged insects, family *Bombycidæ*, or spinners. There are several closely allied species, which spin silk of different qualities, none of which, however, unite strength and fineness in the same admirable proportions as does that of the mulberry species. The latter has, moreover, acquired many useful peculiarities during the long centuries of cultivation it has undergone. It has in fact become a true domesticated animal. The quality which man has endeavored to select in breeding this insect is, of course, that of silk producing, and hence we find that, when we compare it with its wild relations, the cocoons is vastly disproportionate to the size of the worm which makes it or the moth that issues from it. Other peculiarities have incidentally appeared, and the great number of varieties or races of the silkworm almost equals those of the domestic dog. The white color of the species, its seeming want of all desire to escape as long as it is kept supplied with leaves, and the loss of the power of flight on the part of the moth, are all undoubtedly the result of domestica-

Fig. 1.—FULL-GROWN LARVA OR WORM (AFTER RILEY).

tion. From these facts, and particularly from that of the great variation within specific limits to which the insect is subject, it will be evident to all that the following remarks upon the nature of the silkworm must necessarily be very general in their character.

The silkworm exists in four states—egg, larva, chrysalis, and adult or imago—which we will briefly describe.

DIFFERENT STATES OR STAGES OF THE SILKWORM.

The Egg.—The egg of the silkworm moth is called by silk-raisers the "seed." It is nearly round, slightly flattened, and in size resembles a turnip seed. Its color when first deposited is yellow, and this color it retains if unimpregnated. If impregnated, however, it soon acquires a gray, slate, lilac, violet, or even dark green hue, according to variety or breed. It also becomes indented. When diseased it assumes a still darker and dull tint. With some varieties it is fastened to the substance upon which it is deposited by a gummy secretion of the moth produced in the act of ovipositing. Other varieties, however among which may be mentioned the Adrianople whites and the yellows from Nouka, in the Caucasus, have not this natural gum. As the hatching point approaches, the egg becomes lighter in color, which is due to the fact that its fluid contents become concentrated, as it were, into the central, forming worm, leaving an intervening space between it and the shell, which is semi-transparent. Just before hatching, the worm within becoming more active, a slight clicking sound is frequently heard, which sound is, however, common to the eggs of many other insects. After the worm has made its exit by gnawing a hole through one side of the shell, this last becomes quite white. Each female produces on an average from three to four hundred eggs, and one ounce of eggs contains about 40,000 individuals. It has been noticed that the color of the albuminous fluid of the egg corresponds to that of the cocoon, so that when the fluid is white the cocoon produced is also white, and when yellow, the cocoon again corresponds.

The Larva or Worm.—The worm goes through from three to four molts or sicknesses, the latter being the normal number. The periods between these different molts are called "ages," there being five of these ages, including the first from the hatching, and the last from the fourth molt to the spinning period. The time between each of these molts is usually divided as follows: The first period occupies from five to six days, the second but four or five, the third about five, the fourth from five to six, and the fifth from eight to ten. These periods are not exact, but simply proportionate. The time from the hatching to the spinning of the cocoons may, and does, vary all the way from thirty to forty days, depending upon the race of the worm, the quality of the food, mode of feeding, temperature, etc.; but the same relative proportion of time between molts usually holds true.

The color of the newly hatched worm is black or dark gray, and it is covered with long stiff hairs, which upon

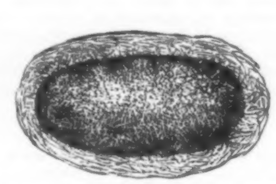


Fig. 2.—SILKWORM COCOON.

close examination will be found to spring from pale colored tubercles. Different shades of dark gray will, however, be found among worms hatching from the same batch of eggs. The hairs and tubercles are not noticeable after the first molt, and the worm gradually gets lighter and lighter until, in the last age, it is of a cream white color. When full grown it presents the appearance of Fig. 1. It never becomes entirely smooth, however, as there are short hairs along the sides, and very minute ones, not noticeable with the unaided eye, all over the body.

The preparation for each molt requires from two to three days of fasting and rest, during which time the worm attaches itself firmly by the abdominal prolegs (the 8 non-articulated legs under the 6th, 7th, 8th, and 9th segments of the body, called prolegs in contradistinction to the 6 articulated true legs under the 1st, 2d, and 3d segments), and holds up the fore part of the body, and sometimes the tail. In front of the first joint a dark triangular spot is at this time noticeable, indicating the growth of the new head; and when the "sickness" is over, the worm casts its old integument, rests a short time to recover strength, and then, freshened, supple, and hungry, goes to work feeding voraciously to compensate for lost time. This so-called "sickness" which preceded the molt was, in its turn, preceded by a most voracious appetite which served to stretch the skin. In the operation of molting the new head is first disengaged from the old skin, which is then gradually worked back from segment to segment until entirely cast off. If the worm is feeble, or has met with any misfortune, the shriveled skin may remain on the end of the body, being held by the anal horn; in which case the individual usually perishes in the course of time. It has been usually estimated that the worm in its growth consumes its own weight of leaves every day it feeds; but this is only an approximation. Yet it is certain that during the last few days before commencing to spin, it consumes more than during the whole of its previous worm existence. It is a curious fact, first noted by Quatrefages, that the color of the abdominal prolegs at this time corresponds with the color of the silk.

Having attained full growth, the worm is ready to spin up. It shrinks somewhat in size, voids most of the excrement remaining in the alimentary canal; acquires a clear, translucent, often pinkish or amber-colored hue; becomes restless; ceases to feed, and throws out silken threads. The silk is elaborated in a fluid condition in two long, slender convoluted vessels, one upon each side of the alimentary canal. As

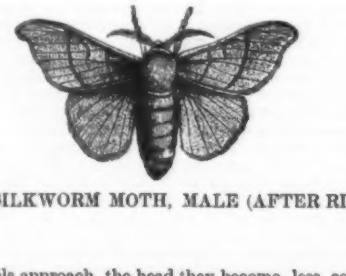


Fig. 3.—SILKWORM MOTH, MALE (AFTER RILEY).

these vessels approach the head they become less convoluted and more slender, and finally unite within the spinneret, from which the silk issues in a glutinous state and apparently in a single thread. The glutinous liquid which combines the two, and which hardens immediately on exposure to the air, may, however, be dissolved in warm water. The worm usually consumes from three to five days in the construction of the cocoon, and then passes in three days more, by a final molt, into the chrysalis state.

The Cocoon.—The cocoon (Fig. 2) consists of an outer lining of loose silk known as "floss," which is used for carding, and is spun by the worm in first getting its bearings. The amount of this loose silk varies in different breeds. The inner cocoon is tough, strong, and compact, composed of a firm, continuous thread, which is, however, not wound in concentric circles as might be supposed, but irregularly, in short figure of 8 loops, first in one place and then in another, so that in reeling, several yards of silk may be taken off without the cocoon turning round. In form the cocoon is usually oval, and in color yellowish, but in both these features it varies greatly, being either pure silvery white, cream or carneous, green, and even roseate, and very often constricted in the middle. It has always been considered possible to distinguish the sex of the contained insect from the general shape of the cocoon, those containing males being slender, depressed in the middle, and pointed at both ends, while the female cocoons are of a larger size and rounder form, and resemble in shape a hen's egg with equal ends. Mr. Crozier, however, emphatically denies this and thinks it "next to impossible for the smartest connoisseur not to be mistaken."

The Chrysalis.—The chrysalis is a brown, oval body, considerably less in size than the full grown worm. In the external integument may be traced folds corresponding with the abdominal rings, the wings folded over the breast, the antennæ, and the eyes of the inclosed insect—the future moth. At the posterior end of the chrysalis, pushed closely up to the wall of the cocoon, is the last larval skin, compressed into a dry wad of wrinkled integument. The chrysalis state continues for from two to three weeks, when the skin bursts and the moth emerges.

The Moth.—With no jaws, and confined within the narrow space of the cocoon, the moth finds some difficulty in escaping. For this purpose it is provided, in two glands near the obsolete mouth, with a strongly alkaline liquid secretion with which it moistens the end of the cocoon and dissolves the hard gummy lining. Then, by a forward and backward motion, the prisoner, with crimped and damp wings, gradually forces its way out, and when once out the wings soon expand and dry. The silken threads are simply pushed aside, but enough of them get broken in the process to render the cocoons, from which the moths escape, comparatively useless for reeling. The moth is of a cream color, with more or less distinct brownish markings across the wings, as in Fig. 3. The males have broader antennæ or feelers than the females, and may by this feature at once be distinguished. Neither sex flies, but the male is more active than the female. They couple soon after issuing, and in a short time the female begins depositing her eggs whether they have been impregnated or not. Very rarely the unimpregnated egg has been observed to develop.

ENEMIES AND DISEASES.

As regards the enemies of the silkworm but little need be said. It has been generally supposed that no true parasite will attack it, but in China and Japan great numbers of the worms are killed by a disease known as "uji," which is undoubtedly produced by the larva of some insect parasite. Several diseases of a fungoid or epizootic nature, and several maladies which have not been sufficiently characterized to enable us to determine their nature, are common to this worm. One of these diseases, called *muscardine*, has been more or less destructive in Europe for many years. It is of precisely the same nature as the fungus (*Empusa muscæ*), which so frequently kills the common house-fly, and which sheds a halo of spores, readily seen upon the window pane, around its victim.

A worm about to die of this disease becomes languid, and the pulsations of the dorsal vessel or heart become insensible. It suddenly dies, and in a few hours becomes stiff, rigid, and discolored; and finally, in about a day, a white powder or efflorescence manifests itself, and soon entirely covers the body, developing most rapidly in a warm, humid atmosphere. No outward signs indicate the first stage of the disease, and though it attacks worms of all ages, it is by far the most fatal in the fifth or last age or stage, just before the transformation.

"This disease was proved by Bassi to be due to the development of a fungus (*Botrytis Bassiana*) in the body of the worm. It is certainly infectious, the spores, when they come in contact with the body of the worm, germinating and sending forth filaments which penetrate the skin, and upon reaching the internal parts give off minute floating corpuscles which eventually spore in the efflorescent manner described. Yet most silkworm raisers, including such good authorities as E. F. Guerin-Meneville and Eugene Robert,* who at first implicitly believed in the fungus origin of this disease, now consider that the botrytis is only the ultimate symptom—the termination of it. At the same time they freely admit that the disease may be contracted by the botrytis spores coming in contact with worms predisposed by unfavorable conditions to their influence. Such a view implies the contradictory belief that the disease may or may not be the result of the fungus; and those who consider the fungus as the sole cause certainly have the advantage of consistency." Dr. Carpenter, of microscopic fame, believes in the fungus origin of the disease, and thinks it entirely caused by floating spores being carried in at the spiracles or breathing orifices of the worm, and germinating in the interior of the body.

Whichever view be held, it appears very clear that no remedies are known, but that care in procuring good eggs, care in rearing the worm, good leaves, pure, even-tempered atmosphere, and cleanliness are checks to the disease. The drawers, and other objects with which the diseased worms may have been in contact, should be purified by fumigations of sulphurous acid (SO_2), produced by mixing bisulphite of soda with any strong acid, or, better still, by subjecting them to a carbolic acid spray from an atomizer. In this way all fungus spores will be destroyed. In fact it will be well to wash off the trays or shelves once in a while with diluted carbolic acid, as a sure preventive. It is the best disinfectant known to science. The cheapest kinds may be used with the same efficacy as the more expensive.

Another disease known as *pébrine*, has proved extremely fatal in Southern Europe, and for twenty years has almost paralyzed silk culture in France. It is a disease which, in its nature and action, except in being hereditary, bears a striking analogy to cholera among men. "The worms affected by *pébrine* grow unequally, become languid, lose appetite, and often manifest discolored spots upon the skin. They die at all ages, but, as in *muscardine*, the mortality is greatest in the last age. The real nature of this malady was for a long time unknown. In 1849, M. Guerin-Meneville first noticed floating corpuscles in the bodies of the diseased worms. These corpuscles were supposed by him to be endowed with independent life, but their motion was afterwards shown by Filippi to depend on what is known as the Brownian motion, and they are now known either by the name of *panhistophyton*, first given them by Lebret, or by that of *psorospermiæ*. They fill the silk canals, invade the intestines, and spread throughout the tissues of the animal in all its different states; and though it was for a long time a mooted question as to whether they were the true cause or the mere result of the disease, the praiseworthy researches of Pasteur

* From a Special Report of the Department of Agriculture.

* "Guide a l'éleveur de vers a soie."

have demonstrated that *pébrine* is entirely dependent upon the presence and multiplication of these corpuscles. He has analyzed the disease so clearly that not only do we see its nature, but are able to point out the remedy. The disease is both contagious and infectious, because the corpuscles which have been passed with the excrement or with other secretions of diseased worms have been taken into the alimentary canal of healthy ones in devouring the soiled leaves, and because it may be inoculated by wounds inflicted by the claws. It is hereditary on the mother's side, because the moth may have the germ of the disease and yet oviposit. Indeed, the eggs may be affected and yet look fair and good, the microscopic *psorospermiæ* not being visible, so that the only true test of disease or health is an examination of the parent moth; and by killing off all infected moths the disease can be controlled.

"Both the diseases mentioned are, therefore, in the strict sense of the word, silkworm plagues; the one of a fungus and the other of an epizootic nature. Each may become epidemic when the conditions are favorable for the undue multiplication of the minute organisms which produce them, or when the checks to the increase of such organisms are removed by carelessness or ignorance." Cleanliness and purification are absolutely necessary in treating both these diseases, and in *pébrine* care must be taken that the eggs are sound by a microscopic examination of the moths. This may be done after the eggs are laid, and if the corpuscles be found in the mother, her eggs should be discarded.

Silkworms are subject to other diseases, but none of them have ever acquired the importance of those described. What is called *gattine* by older authors is but a mild phase of *pébrine*. The worms are apt to be purged by unwholesome leaves; too great heat makes them sickly; or they may become yellow, limp, and die of a malady called *grasserie* or jaundice, which is almost sure to appear in large broods, and which is very common in those reared in this country. When the worms die from being unable to molt they are called *lusettes*, and such cases are most abundant at the fourth molt. All these different ailments, and others not mentioned, have received names, some local, others more general; but none of them warrant further notice here, as they are not likely to become very troublesome if proper attention and care be given to the worms.

VARIETIES OR RACES.

As before stated, domestication has had the effect of producing numerous varieties of the silkworm, every different climate into which it has been carried having produced either some changes in the quality of the silk, or the shape or color of the cocoons, or else altered the habits of the worm.

Some varieties produce but one brood in one year, no matter how the eggs are manipulated; such are known as *annuals*. Others, known as *bivoltins*, hatch twice in the course of the

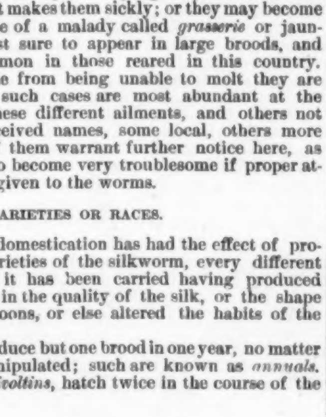


FIG. 4.—SHAPES OF SILKWORM COCOONS.

year; the first time, as with the annuals, in April or May, and the second, eight or ten days after the eggs are laid by the first brood. The eggs of the second brood only are kept for the next year's crop, as those of the first brood always either hatch or die soon after being laid. The *trevoltins* produce three annual generations. There are also *quadrivoltins*, and, in Bengal, a variety known as *dacey* which is said to produce eight generations in the course of a year. Some varieties molt but three times instead of four, especially in warm countries and with trevoltins. Experiments taking into consideration the size of the cocoon, quality of silk, time occupied, hardiness, quantity of leaves required, etc., have proved the annuals to be more profitable than any of the polyvoltins, although bivoltins are often reared; and Mr. Alfred Brewster, of San Gabriel, Cal., says that he found a green Japanese variety of these last more hardy than the Chinese annuals. Varieties are also known, by the color of the cocoons they produce, as greens, or whites, or yellows, and also by the country in which they flourish. The white silk is the most valuable in commerce, but the races producing yellow, cream colored, or flesh colored cocoons are generally considered to be the most vigorous. No classification of varieties can be attempted, as individuals of the same breed exported to a dozen different localities would, in all probability, soon present a dozen varieties.

The three most marked and noted European varieties are the Milanese (Italian) breed, producing the small yellow cocoons; the Ardèche (French), producing large yellow cocoons, and the Brousse (Turkish), producing large white cocoons of the best quality in Europe. Owing to the fearful prevalence of *pébrine* among the French and Italian races for fifteen or twenty years back, the Japanese annuals have come into favor. The eggs are bought at Yokohama in September, and shipped during the winter. There are two principal varieties in use, the one producing white and the other greenish cocoons, and known respectively as the white Japanese and the green Japanese annuals. These cocoons are by no means large, but the pods are solid and firm, and yield an abundance of silk. They are about of a size, and both varieties are almost always constricted in the middle (Fig. 4, *c* green, *d* white). Another valuable race is the white Chinese annual (Fig. 4, *e*), which much resembles the white Japanese, but is not as generally constricted. Fig. 4, *a* and *b*, represent, respectively, white and yellow French annuals.

WINTERING AND HATCHING THE EGGS.

We have already seen the importance of getting healthy eggs, free from hereditary disease, and of good and valuable races. There is little danger of premature hatching until December, but from that time on the eggs should be kept in a cool, dry room in tin boxes to prevent the ravages of rats and mice. They are most safely stored in a dry cellar, where the temperature rarely sinks below the freezing point, and they should be occasionally looked at to make sure that they are not affected by mould. If, at any time, mould be perceived upon them it should be at once rubbed or brushed off, and the atmosphere made drier. If the tin boxes be perforated on two sides and the perforations covered with fine wire gauze, the chances of injury will be reduced to a minimum.

The eggs may also, whether on cards or loose,* be tied up in small bags and hung to the ceiling of the cold room. The string of the bag should be passed through a bottle neck or a piece of tin to prevent injury from rats and mice. The temperature should never be allowed to rise above 40° F., but may be allowed to sink below freezing point without injury. Indeed, eggs sent from one country to another are usually packed in ice. They should be kept at a low temperature until the mulberry leaves are well started in the spring, and great care must be taken as the weather grows warmer to prevent hatching before their food is ready for them, since both the mulberry and Osage orange are rather late in leafing out. One great object should be, in fact, to have them all kept back, as the tendency in our climate is to premature hatching. Another object should be to have them hatch uniformly, and this is best attained by keeping together those laid at one and the same time, and by wintering them, as already recommended, in cellars that are cool enough to prevent any embryonic development. They should then, as soon as the leaves of their food plant have commenced to put forth, be placed in trays and brought into a well-aired room where the temperature averages about 75° F. If they have been wintered adhering to the cloth on which they were laid, all that is necessary to do is to spread this same cloth over the bottom of a tray. If, on the contrary, they have been wintered in the loose condition, they must be uniformly sifted or spread over sheets of cloth or paper. The temperature should be kept uniform, and a small stove in the hatching-room will prove very valuable in providing this uniformity. The heat of the room may be increased about 2° each day, and if the eggs have been well kept back during the winter, they will begin to hatch under such treatment on the fifth or sixth day. By no means must the eggs be exposed to the sun's rays, which would kill them in a very short time. As the time of hatching approaches the eggs grow lighter in color, and then the atmosphere must be kept moist artificially by sprinkling the floor, or otherwise, in order to enable the worms to eat through the egg shell more easily. They also appear fresher and more vigorous with due amount of moisture.

FEEDING AND REARING THE WORMS.

The room in which the rearing is to be done should be so arranged that it can be thoroughly and easily ventilated, and warmed if desirable. A northeast exposure is the best, and buildings erected for the express purpose should, of course, combine these requisites. If but a few worms are to be reared, all the operations can be performed in trays upon tables, but in large establishments the room is arranged with deep and numerous shelves, from 4 to 8 feet deep and 2 feet 6 inches apart. All wood, however, should be well seasoned, as green wood seems to be injurious to the health of the worms. When the eggs are about to hatch, mosquito-netting or perforated paper should be laid over them lightly. Upon this can be evenly spread freshly plucked leaves or buds. The worms will rise through the meshes of the net or the holes in the paper and cluster upon the leaves, when the whole net can easily be moved. In this moving, paper has the advantage over the netting, in that it is stiffer and does not lump the worms together in the middle. They may now be spread upon the shelves or trays, care being taken to give them plenty of space, as they grow rapidly. Each day's hatching should be kept separate in order that the worms may be of a uniform size, and go through their different moltings or sicknesses with uniformity and regularity; and all eggs not hatched after the fourth day from the appearance of the first should be thrown away, as they will be found to contain inferior, weakly, or sickly worms. It is calculated that one ounce of eggs of a good race will produce 100 pounds of fresh cocoons; while for every additional ounce the percentage is reduced if the worms are all raised together, until for 20 ounces the average does not exceed 25 pounds of cocoons per ounce. Such is the general experience throughout France, according to Guérin Méneville, and it shows the importance of keeping them in small broods, or of rearing on a moderate scale.

The young worms may be removed from place to place by means of a small camel's hair brush, but should be handled as little as possible. The best mode of feeding and caring for them is by continuing the use of the feeding net first mentioned. As the worms increase in size the net must have larger meshes, and if it should be used every time fresh food is furnished, it will save a large amount of time and care. It entirely obviates the necessity of handling the worms, and enables the person having charge of them to keep them thoroughly clean; for, while they pass up through the net to take their fresh food, their excrement drops through it and is always taken up with the old litter beneath. It also acts as a detective of disease: for such worms as are injured, feeble, or sickly, usually fail to mount through the meshes and should be carried off and destroyed with the refuse in the old net below. This placing on of the new net and carrying away of the old is such a great convenience and time-saver that in France, for many years, paper, stamped by machinery with holes of different sizes, suited to the different stages of the worms, has been used. The paper has the advantage of cheapness and stiffness, but a discussion as to the best material is unnecessary here, the aim being to enforce the principle of the progressive rise of the worms. Details will suggest themselves to the operator.

When the nets are not used, there is an advantage in feeding the worms upon leaf-covered twigs and branches, because these last allow a free passage of air, and the leaves keep fresh a longer time than when plucked. In thus feeding with branches consists the whole secret of the California system, so much praised and advocated by M. L. Prevost. The proper, stamped paper not being easily obtained in this country, mosquito-netting will be found a very fair substitute while the worms are young, and when they are larger I have found thin slats of some non-resinous and well-seasoned wood, tacked in parallel lines to a frame just large enough to set in the trays, very serviceable and convenient—small square blocks of similar wood being used at the corners of the tray to support the frame while the worms are passing up through it. Coarse twine netting stretched over a similar frame will answer the same purpose, but wire netting is less useful, as the worms dislike the smooth metal.

Where branches, and not leaves, are fed, the Osage orange has the advantage of mulberry, as its spines prevent too close settling or packing, and thus insure ventilation. It is recommended by many to feed the worms while in their first age, and, consequently, weak and tender, leaves that have been cut up or hashed, in order to give them more edges to eat upon and to make less work for them. This, however, is hardly necessary with annuals, although it is quite generally practiced in France. With the second brood of bivoltins it might be advisable, inasmuch as the leaves at the season of the year when they appear have attained their full growth and are a little tough for the newly-hatched individuals. In the spring, however, the leaves are small and tender, and nature has provided the young worms with sufficiently strong jaws to cut them.

Many rules have been laid down as to regularity of feeding, and much stress has been put upon it by some writers, most advising four meals a day at regular intervals, while a given number of meals between molts has also been urged; but such definite rules are but of little avail, as so much depends upon circumstances and conditions. The food should, in fact, be renewed whenever the leaves have been devoured, or whenever they have become in the least dry, which, of course, takes place much quicker when young and tender than when mature. This also is an objection to the use of the hashed leaves, as, of course, they would dry very quickly. The worms eat most freely early in the morning and late at night, and it would be well to renew the leaves abundantly between 5 and 6 A.M. and between 10 and 11 P.M. One or two additional meals should be given during the day, according as the worms may seem to need them. Great care should be taken to pick the leaves for the early morning meal the evening before, as when picked and fed with the dew upon them they are more apt to induce disease. Indeed, the rule should be laid down, never feed wet or damp leaves to your worms. In case they are picked during a rain, they should be thoroughly dried before being fed; and on the approach of a storm it is always well to lay in a stock, which should be kept from heating by occasional stirring. Care should also be taken to spread the leaves evenly, so that all may feed alike. During this first and most delicate age the worm requires much care and watching.

As the fifth or sixth day approaches, signs of the first molt begin to be noticed. The worm begins to lose appetite and grow more shiny, and soon the dark spot already described appears above the head. Feeding should now cease, and the shelves or trays should be made as clean as possible. Some will undoubtedly undergo the shedding of the skin much more easily and quickly than others, but no feed should be given to these forward individuals until nearly all have completed the molt. This serves to keep the batch together, and the first ones will wait one or even two days without injury from want of food. It is, however, unnecessary to wait for all, as there will always be some few which remain sick after the great majority have cast their skins. These should either be set aside and kept separate, or destroyed, as they are usually the most feeble and most inclined to disease; otherwise, the batch will grow more and more irregular in their moltings and the diseased worms will contaminate the healthy ones. It is really doubtful whether the silk raised from these weak individuals will pay for the trouble of rearing them separately, and it will be better perhaps to destroy them. The importance of keeping each batch together, and of causing the worms to molt simultaneously, cannot be too much insisted upon as a means of saving time.

As soon as the great majority have molted they should be copiously fed, and, as they grow very rapidly after each molt, and as they must always be allowed plenty of room, it will probably become necessary to divide the batch, and this is readily done at any meal by removing the net when about half of the worms have risen and replacing it by an additional one. The space allotted to each batch should, of course, be increased proportionately with the growth of the worms. The same precautions should be observed in the three succeeding molts as in this first one.

As regards the temperature of the rearing room, great care should be taken to avoid all sudden changes from warm to cold, or *vice versa*. A mean temperature of 75° or 80° F. will usually bring the worms to the spinning point in the course of 35 days after hatching, but the rapidity of development depends upon a variety of other causes, such as quality of leaf, race of worm, etc. If it can be prevented, the temperature should not be permitted to rise very much above 80°, and it is for this reason that a room with a northern or northeastern exposure was recommended as preferable to any other. The air should be kept pure all of the time, and arrangements should be made to secure a good circulation. Great care should be taken to guard against the incursions of ants and other predacious insects, which would make sad havoc among the worms were they allowed an entrance, and all through the existence of the insect, from the egg to the moth, rats and mice are on the watch for a chance to get at them, and are to be feared almost as much as any other enemy the silkworm has.

The second and third casting of the skin takes place with but little more difficulty than the first, but the fourth is more laborious, and the worms not only take more time in undergoing it, but more often perish in the act. At this molt it is perhaps better to give the more forward individuals a light feed as soon as they have completed the change, inasmuch as it is the last molt and but little is to be gained by the retardation, whereas it is important to feed them all that they will eat, since much of the nutriment given during the last age goes for the elaboration of the silk. At each successive molt the color of the worm has been gradually whitening, until it is now of a decided cream color. Some breeds, however, remain dark, and occasionally there is an individual with zebra-like markings. During these last few days the worms require the greatest care and attention. All excrement and litter must be often removed, and the sickly and diseased ones watched for and removed from the rest. The quantity of leaves which they devour in this fifth age is something enormous, and the feeding will keep the attendant busily employed.

Summed up, the requisites to successful silkworm raising are: 1st. Uniformity of age in the individuals of the same tray, so as to insure their molting simultaneously. 2d. No intermission in the supply of fresh food, except during the molting periods. 3d. Plenty of room, so that the worms may not too closely crowd each other. 4th. Fresh air and as uniform temperature as possible. 5th. Cleanliness. The last three are particularly necessary during the fourth and fifth ages. While small the frass, dung, and detritus dry rapidly, and may (though they should not) be left for several

* For explanation, see what follows under egg-laying.

days in a tray with impunity, but he who allows his trays to go uncleaned for more than a day during the ages mentioned will suffer in the disease and mortality of his worms just as they are reaching the spinning point.

(To be continued.)

THE DINOSAURS OF THE ROCKY MOUNTAINS.

Prof. A. Lakes, Colorado School of Mines.

From time to time we hear of discoveries of remains of gigantic monsters in our mountains. Some of these have been rather tall stories, founded on a certain amount of fact with an uncertain amount of imagination. Having ourselves discovered several of these monsters, and having been in their close society for some weeks at Yale, we would offer to your readers some account of what is known of these huge forefathers of the race according to Prof. Marsh and the best authorities.

Many thousands, perhaps millions, of years ago a long, tropical arm of the sea extended from the Gulf of Mexico over our western plains and Rocky Mountains, before the Rockies had attained their present height.

There were islands in those seas covered with semi-tropical firs and small palmettoes, willows, and other trees, and these islands were marshy in places. Along these marshes walked some of the most gigantic forms the world has ever seen. Monarchs of sea and land, these were the dinosaurs or truly terrible lizards, and their remains are traceable for many hundreds of miles in a narrow belt of rock along the base of the Rocky Mountains. These creatures, which in their anatomy are intermediate between running birds, like the ostrich, and reptiles, such as crocodiles, were, for the most part, of enormous size; some from seventy to eighty feet in length, and of great bulk; others were no larger than a cat. These were, for the most part, herbivorous in their habits. The skin of these animals was sometimes naked, sometimes furnished with an outside skeleton of bony shields like alligators, which they more resembled than most living animals. Some of their vertebræ had a hollow cavity looking toward the tail; hence they are called opisthocœlons, or hollow behind. The trunk ribs of the upper portion of the body were double-headed. The teeth were confined to jaws, and implanted in distinct sockets. There were two pairs of limbs with claws, and in some cases the fore limbs were small in proportion to the hind limbs. The astragalus bone of the feet much resembles that of a bird. The dinosaurs belong to what is called the Mesozoic period, the great age of reptiles. and when the chalk of England was forming at the bottom of the sea, and over many parts of the Old and New Worlds, reptiles of the most extraordinary as well as gigantic forms were inhabiting both sea and land. Such were the iguanodons, megalosaurus, cetrosaurus, and others. The iguanodon was a huge reptile twenty-five to thirty feet long, so called because its crenated teeth resembled those of the little modern iguana. It was herbivorous, and that it stood high may be judged from a thigh bone five feet long, with a circumference of twenty-two inches. From the small size of its fore limbs, and occurrence of the tracks of pairs of gigantic three-toed footsteps left upon the rocks, it is indicated that it sometimes walked on its hind limbs like birds.

A still greater monster called the cetrosaurus, found in Europe, was from forty to fifty feet long. It stood ten feet in height, according to Prof. Philips, and was unmatched in size and strength by inhabitants of sea and land. As to whether it lived in sea or on land is a little doubtful, owing to some of its bones being found in marine, others in estuary, and others in river accumulations. The structure of its limbs for walking implies that it took a "constitutional" at any rate, when so disposed, on "terra firma." The projection of the head of the femur in the acetabulum claims a free step. The large claws also imply land habits. It may, however, have been amphibious, and the vertical height of the upper portion of the tail implies this. So we have a marsh loving animal dwelling among ferns, cycads, and conifers, full of insects and small mammals. From its teeth it appears to have been herbivorous, like the iguana.

The megalosaurus is another oolitic reptile from twenty to thirty feet long, with tibia and femur each three feet, giving a leg of six or seven feet in length. The position of the head of the femur, at right angles with the shaft and long bones containing medullary cavities, implies that its habits were also terrestrial and carnivorous, as shown by its trenchant teeth, which are conical, compressed, and with serrated edges. The fore limbs are very much smaller than the hind limbs, and there is no exoskeleton or outside skeleton. To these worthies we might add the compsognathus of Sohlenhofer, which is more like a bird than the other dinosaurs.

In true dinosaurs the neck was short, the femur longer than the tibia, and very much like a bird. The head of compsognathus was furnished with hooked jaws, supported on a long slender neck, the fore limbs short, and out of proportion to the hind limbs, and also like a bird in structure. The same relationship is noted in the tarsus or ankle joint of the foot, which was united to the tibia, while again in other respects it was unlike birds. Huxley considers that some of these creatures hopped like birds, in an erect position, to which class of beings, especially the compsognathus, with its long neck, slight head, hollow bones, and small fore limbs, gives an extraordinary resemblance.

We now come to the description of our own domestic monsters which inhabit the Rocky Mountains.

On the flanks of the mountains is a narrow belt of stratum, traceable for hundreds of miles, and marked here and there by bones of these gigantic dinosaurs. Its position is above the trias and below the hard sandstones of the Dakota, which, by the way, contain many leaves of an extraordinary character, being the first dicotyledons that are known upon this planet. By Dr. Hayden this belt was supposed to be cretaceous in age, but the abundant vertebrate remains discovered by Capt. H. C. Beckwith and myself, Prof. Mudge, and also by Mr. Lucas, at Cañon City, and by Mr. Williston, of Prof. Marsh's party, in Wyoming, prove, according to Prof. Marsh, its Jurassic age, and in honor of one of the largest monsters characteristic of these beds, he has called them the atlantosaurus beds. The stratum is estuary, being deposits of shale and sandstone, and seems to correspond to the Wealden, of Europe. Besides the dinosaurs, remarkable crocodiles, tortoises, and fishes a pterodactyl and a mammal were discovered. These differ somewhat from the true dinosaurs. The atlantosaurus immanis, of Morrison, was at least 80 feet in length, and others equaled it in bulk. But with these terrible great lizards, there were also some scarcely terrible little lizards—the nanosaurs, no larger than a cat. These dinosaurs resembled somewhat the crocodiles of the Mesozoic period. We may give some of their most striking characteristics. The fore limbs and hind limbs of the atlantosaurs were nearly equal in size, so there is no particular reason for their aping the bird by walking on their hind feet, that we know of. The carpal and tarsal bones were distinct. The feet were plantigrade, and had five toes. The precaudal vertebræ contain large cavities, as it were bored in them, supposed to assist in lightening the great weight of the vertebræ, and, being filled with air, are called pneumatic cavities. The neural arches are united to the center by suture. The sacral vertebræ, a number of vertebræ generally united to form a strong attachment for the tail, consist of not more than four in number, each having its transverse process.

There was a relative of his, called diplodocus, 50 feet long, and another, laosaurus, not 10 feet long. There was a monster, however, at Morrison, some hundreds of miles from where the former were found, called apatosaurus ajax, one of the vertebræ of whose colossal neck was 3½ feet in width, and implies a neck full 5 feet wide. The getting out of this last monster, through the snows of winter, was attended with no little peril to the party. A ledge of rock some hundreds of tons in weight, under which the scientists had been digging, giving way with a crash during the night. Had it fallen in the daytime, bones historic would have been added to those primeval. But even these great herbivorous lizards were not without their foes. There were the allosauridæ, carnivorous dinosaurs, averaging from 20 to 25 feet in length, their feet armed with sharp claws. One of these was called creosaurus, flesh eater, a cannibal among his kind.

While the atlantosaurs were a distinct family, they belonged to a sub-order called sauropoda, or lizard-footed. A very perfect skeleton of one of these found by Mr. Williston, in Wyoming, may be taken as typical. Its head was small, showing by the fixed quadrate bone of the jaw and other features a resemblance to crocodiles. The rami of the lower jaw were not united by symphyses. The teeth were numerous, the neck was long, and the vertebræ had deep cavities in them, to lighten them, as in birds of flight. These vertebræ were hollow behind. The humerus bone was massive, and its ends roughened and covered with cartilage. The toes were thick, and had strong, hoof-like claws. This animal, when alive, was full 40 feet long, and walked on all-fours. Its movements were probably sluggish, and it does not seem to have suffered from too deep meditation, as its brain cavity was extraordinarily small—smaller than any known vertebrate not one-tenth of its size.

We next come to a huge reptile, also of Morrison, whose remains are embedded in so hard a matrix of rock, that Prof. O. C. Marsh, who was at work at them for weeks after the party in the field had blasted them in more senses than one, called out a parody on his name in the lines:

> "Break! break! break! at thy cold, gray stones, O. C.!
> And I would that my tongue could utter the thoughts that arise in me."
> etc.

This monster was a nondescript, part dinosaur, part plesiosaur, and part turtle, at least he seemed related to them all. The teeth have compressed crowns, and are inserted in sockets. Others of a cylindrical character, more probably spines of the backbone, are placed in rows of imperfect bone or cartilage. The vertebræ are biconcave. The limb bones indicate an aquatic life. The long body was protected by large, bony plates, like the great turtle atlantochelys, supported by long spines of the vertebræ. One of these plates was 3 feet long. It was about 30 feet long, and moved by swimming. It was the mailed warrior of the lakes and ponds.

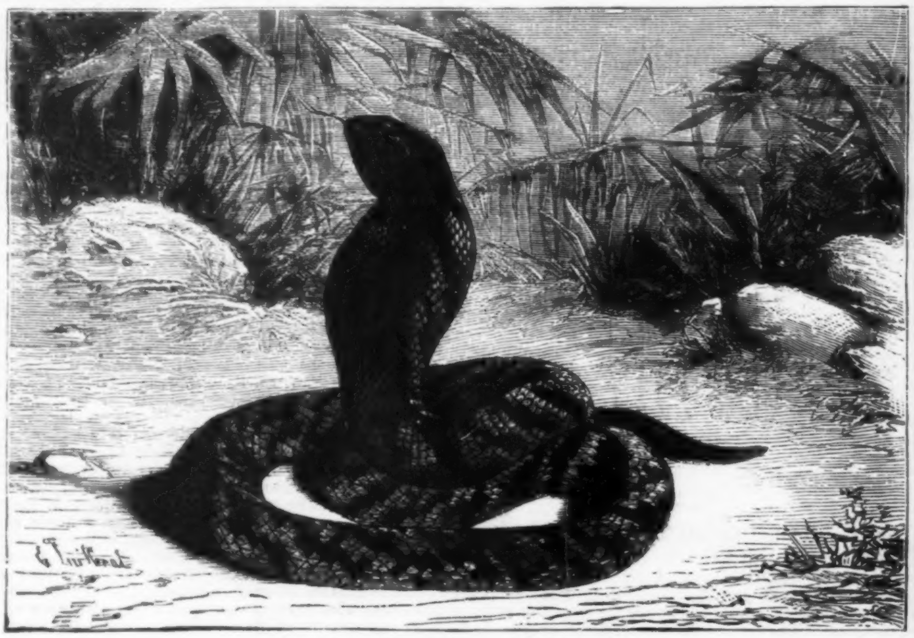
Such were some of the monsters which enjoyed themselves in olden times around the Rocky mountains, then islets just peeping above an inland sea. In the marshes and bayous of these islets the atlantosaurus and other dinosaurs enjoyed life, sometimes plunging in for a bath, at other times walking boldly on the land and cropping the leaves from the primeval forests. All their friends and foes were reptilian; even the birds were half reptiles, and armed with teeth, and the mammals, such as they were, were also allied to the reptiles. All the reptiles laid eggs—and what an egg must Mrs. Atlantosaurus have laid! She is supposed to have been 100 feet long, and, judging from her huge thigh-bone, 9 feet long probably, standing erect, 18 to 25 feet. Truly the roc's egg, found by Sindbad, must have been the only approximation to it. The climate was warm and uniform, as attested by the fauna and flora of a warm tropical sea, which occupied the western prairies and plains from the Gulf of Mexico over the Wahsatch range. The period closed by a bodily upheaval of the whole western half of the continent, by which the cretaceous sea was drained off, and this, no doubt, caused the death of many of those monsters, though most of them probably died like other creatures, or were mired in the mud which now entombs them in the form of sandstone, uplifted by mountain upheaval, like angry waves surging toward the shore, but unpoetically known in those regions by the name of hogbacks. —*Kansas City Review.*

THE MARBLED SEPEDON.

The menagerie attached to the museum at the Jardin des Plantes, at Paris, has just received from the Cape of Good Hope a serpent, the *Sepedon hæmachata*—no living specimen of which had ever been seen before in Europe.

About the middle of the last century, Seba—a naturalist who has given us numerous valuable plates of animals—figured, under the name of *Hæmachata*, two serpents, which, according to him, were natives of Persia and Japan. The reptile is marked with brilliant red blotches, variegated with white streaks, making the upper part of its body appear as if marbled, and from this fact is derived the specific name. Later on, Lacepede, recognizing the analogy that existed between the *Hæmachata* and the najas, placed it near the vipers. The precise locality where the animal was found, however, is not mentioned by the French naturalist. It was in 1826 that Mr. Smith, in his narrative of a voyage to the Cape, pointed out Southern Africa as the home of the Cape Naja; all specimens received into collections of animals since that time have come from this region, so that it is certain that Seba has fallen into an error as to the origin of the two serpents figured by him.

The *Sepedon hæmachata* is an animal which often attains a length of over 3 feet. Its head, scarcely wider than its body, is even above, and covered with large plates. The animal when irritated has, like the najas, the power of puffing out its neck so as to form a broad disk resembling a hood. Its whole body is covered with imbricated, strongly keeled scales. According to Mr. Smith, who has observed the animal in a living state, the ground color of the dorsal and lateral parts of the body is of a bluish or grayish brown, variegated with a large number of narrow, transverse, wavy, notched bands, the color of which varies from an ocherous-yellow to a clear yellowish-white. The throat is of a pale black or of a dark red brown, and the ventral portion of the body of a grayish black or lead color. On the forepart are seen two or three transverse, yellowish bands; and on the sides a few irregular white blotches. The tail is variegated with black and yellow; the eyes are of a dark brown. The two serpents that the museum has has just received are of a grayish black, the body being



THE MARBLED SEPEDON.

striped with wavy transverse bands of a grayish yellow color; the head is black, the extremity of the snout yellowish, and the underside of the jaws is brownish, with irregularly disposed yellow blotches, and a black line following the axis of the body.

The only information that we possess in regard to the habits of the Hœmachata is derived from Mr. Smith. This serpent, says the latter, seems to prefer soft and sandy soils covered with brush. It is one of the most vigilant of ophidians, and when it is desired to capture one it is rare that it can be taken unawares. It always appears in a threatening attitude, and ready to defend itself. When it takes to flight it usually seeks some subterranean retreat, and it is easy to find one of these, since it lives in places where the holes of rats, moles, and other small quadrupeds are numerous. The natives of the country, as well as the colonists, regard this serpent as the most courageous of all those that inhabit Africa, and they stand in great dread of the fatal energy of its poison. If irritated while in captivity, it exhibits a great deal of ferocity, opening its mouth as if to seize the object approaching it. At such moments drops of poison may be seen exuding from the fangs, which are always raised and placed in the most convenient position for performing their function. During this period of excitement, it often lets drop a small quantity of the venom from its mouth. According to observations made on the animals preserved in the museum, these statements of Smith are found to be perfectly accurate. When the sepedon is approached, it at once turns, arises vertically for about a fourth or fifth of the length of its body, its head erect and bent slightly back, its mouth open, its fangs exserted, in the best position possible, in a word, to strike its victim; at the same time its neck dilates (like that of the Indian cobra), the collar being of a deep black with yellowish edges spotted with brown. The animal thus on the defensive follows all the movements of its enemy. When it strikes it lowers both its head and the position of the body that was erect, so that by this very movement it must be rarely that the poison fangs reach the victim. During this movement it makes a sharp whistling sound. It then immediately rises again and puts itself upon the defensive, ready to strike anew.